Chapter Four: Overview of the Massachusetts Division of Fisheries & Wildlife

A. History and Structure of Massachusetts Division of Fisheries and Wildlife

The Division of Fisheries and Wildlife (MDFW) was founded as a state fisheries commission in 1866 in response to citizen concerns about the loss of Atlantic salmon to dams and pollution. The continuing development of the agency from that time until the present reflects the will of the citizens of Massachusetts to protect and restore our natural resources.

The conservation — including protection, restoration, and management — of Massachusetts fauna and flora is the statutory responsibility of the MDFW. Specifically, the MDFW is charged with the stewardship of all wild amphibians, reptiles, birds, mammals, and freshwater and diadromous fishes in the state, including endangered, threatened, and special concern species, and all native wild plants and invertebrates. This responsibility is established and articulated in the Constitution and General Laws of the Commonwealth of Massachusetts.

As the base of scientific knowledge regarding the interdependence of all environmental factors has grown, coupled with progressive, pragmatic leadership, the mission of the MDFW has evolved to include all aspects of the environment. The MDFW is committed to an evolving stewardship philosophy and to continued leadership in conservation and management of the environment.

The MDFW, which is one several divisions within the Department of Fish and Game (which is itself one of several departments within the Executive Office of Environmental Affairs), employs about 140 staff members and operates on an $11 million annual budget. The agency is overseen by the seven-member Fisheries and Wildlife Board appointed by the Governor. Under Chapter 21, the Board supervises and controls the agency, having authority to make regulations, set policy, and oversee personnel appointments.

The Director, who reports directly to the Board, supervises the Division through the Deputy Director of Administration and the Deputy Director of Field Operations, who are responsible for supervision and coordination of activities within the Division. The Division has three research sections (Wildlife, Fisheries, and Natural Heritage & Endangered Species) and three support sections (Administration, Wildlife Lands, and Information & Education).

The Natural Heritage and Endangered Species Advisory Committee, established in 1981, is another seven-member citizen body. Its responsibility is to advise the Director on matters dealing with non-game topics. In practice, it also provides the Fisheries and Wildlife Board with independent, scientific advice on the conservation and protection of over 400 species of wild plants and animals that are not hunted, fished or trapped. In addition, the Committee advises the Natural Heritage and Endangered Species Program on matters such as promotion of the Natural

Heritage Fund, funding priorities for biological field research and inventory, and as well as other issues concerning the protection of biodiversity in Massachusetts.

Although organized in three functional units, the Wildlife, Fisheries, and Natural Heritage and Endangered Species Sections are operated in a manner that integrates the biological management efforts of the agency. For example, forest land management plans integrate forestry practices to achieve wildlife management objectives such as creating habitats to benefit neotropical migrant birds, upland game birds, and watershed protection. It also demonstrates the value of appropriate wildlife management practices to private landowners. Another example is the application of environmental review by the Fisheries and the Natural Heritage and Endangered Species Sections. These sections maintain inventory data on fresh water fisheries resources, aquatic systems, endangered, threatened, and special concern plant and animal species, and natural communities throughout the state. They review potential impacts of proposed development on those resources, rare species and their habitats under the Massachusetts Environmental Policy Act (MEPA), Endangered Species Act (MESA), and Wetlands Protection Act. The MDFW plays an integral part in interjurisdictional management through cooperation with federal, other state, and local conservation agencies on matters of mutual concern, such as intrabasin diversions of water, anadromous fish restoration (e.g. Atlantic salmon, American shad), and endangered species restoration (e.g. piping plover, bald eagle, peregrine falcon). The MDFW is committed to the maintenance of biodiversity and the conservation of wetlands and uplands by use of its ability to protect the state's flora and fauna through regulation, environmental permitting, and acquisition of property.

In order to preserve wildlife habitats, one of the highest priorities of the MDFW is habitat acquisition. Field Operations staff (particularly District Managers and their staff), other MDFW staff, Board members and conservation partners of the MDFW are all involved in identifying lands for acquisition by the MDFW. The habitat acquisition process is used for all Bond and Wildlands Conservation Stamp acquisitions. The goals of acquisition are to protect and perpetuate ecosystems that contain significant fish and wildlife resources, to conserve biological diversity, and to provide adequate routes for public access to the lands and waters. Potential acquisitions are reviewed and prioritized by the Lands Committee, which determines their resource and recreational value. Negotiations and processing are carried out by a core staff consisting of a Bond Fund Administrator, Chief of Wildlife Lands, an attorney, a paralegal and five land agents. Technical input is provided by the Districts and a representative from each of the three research sections (Fisheries, Wildlife, and Natural Heritage and Endangered Species). Massachusetts law requires the review and approval of all acquisitions by the Fisheries and Wildlife Board.

The structure and goals of the agency reflect its commitment to the conservation of diversity of both the flora and fauna. Its approach reflects the integrated nature of the resources for which it is responsible through the General Laws of the Commonwealth.

B. The MDFW Approach toward Protecting Biodiversity

1. Natural Heritage and Endangered Species Program

Structure and Functions
The Natural Heritage & Endangered Species Program (NHESP) is part of the Division of Fisheries and Wildlife (MDFW) and is responsible for the conservation and management of hundreds of species that are not hunted, fished, trapped, or commercially harvested in the state. The Program's highest priority is protecting the approximately 450 species of vertebrate and invertebrate animals and native plants that are officially listed as Endangered, Threatened or of Special Concern in Massachusetts.

The Program currently has a staff of approximately 30, supported by citizen donations, publication sales, project-related state environmental bond funds, and grants. The Natural Heritage & Endangered Species Advisory Committee oversees and guides NHESP activities. The role of the Committee is to provide the MDFW with independent scientific advice on the conservation and management of rare species and exemplary natural communities in Massachusetts. In addition, the Committee advises the NHESP on matters such as promotion for the Natural Heritage & Endangered Species Fund (which receives donations from a voluntary "checkoff" on state income tax forms, generating about $200,000 annually), funding priorities for biological field research and inventory, and other issues concerning the protection of biodiversity in Massachusetts.

The Massachusetts Fisheries and Wildlife Board first established an ad hoc Natural Heritage & Endangered Species Advisory Committee in 1981. In 1983, the Committee was formally established by the legislature (M.G.L. ch.131, section 5B) as the Non-Game Advisory Committee at the same time the income tax form contribution law, or "check-off", was passed. The Committee's name was changed to its current name in 2002, to more accurately reflect the Committee's broad role. The Commissioner of the Department of Fish and Game, with the approval of the Fisheries and Wildlife Board, appoints the members of the Advisory Committee. The Committee makes recommendations to the Board and the MDFW Director. There are seven Committee members, and an equal number of Associate Members. The Committee meets monthly, typically at the MDFW office in Westborough. The meetings are always open to the public, which is encouraged to attend and often does.

The overall goal of the NHESP is the protection of the state's wide range of native biological diversity. Progress towards this goal is accomplished through the following:

- Biological Field Surveys
- Research and Monitoring
- Data Management
- Environmental Impact Review
- Rare Species Recovery,
- Ecological Restoration of Key Habitats
- Land Protection

Collecting Biological Data
The NHESP gathers data on the numbers, distribution, and conservation needs of rare plant and animal species and exemplary natural communities throughout the state. Over 14,000 recent and historical records of rare species and natural community occurrences are maintained in the NHESP database. These site-specific data are used to direct conservation efforts in the form of research, land protection, habitat management, and environmental impact reviews. The NHESP serves as one of the state programs forming the national Natural Heritage network organized by the non-profit organization NatureServe.

Recovering Rare Species
The NHESP has helped restore populations of rare species to the state including the Bald Eagle, Peregrine Falcon, American Burying Beetle, and Northeastern Beach Tiger Beetle, and, through habitat and species management, has increased the state's populations of many other species. For example, Piping Plovers have increased in the state from about 130 pairs in 1985, to more than 500 pairs in 2003, through the intensive efforts of NHESP biologists and many cooperators.

Reviewing Environmental Impacts
The NHESP reviews numerous and varied projects annually under the Massachusetts Endangered Species Act, the Massachusetts Wetlands Protection Act regulations, and other environmental laws for their potential impact on state-listed rare species and their habitat. The NHESP also certifies vernal pools, which then receive enhanced regulatory protection.

Protecting Habitat
Rare species in Massachusetts are threatened primarily by habitat loss and degradation. The NHESP identifies the habitats critical to rare species and helps prioritize the Division's land acquisition efforts. NHESP staff also helps other state and federal agencies, land conservation groups, and municipalities to set biodiversity conservation priorities and helps them protect and manage land for rare species.

Recent Projects
In recent years the NHESP has, in addition to its continuing functions, produced three major publications to help guide the conservation of biodiversity in the Commonwealth:

- *Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts;*
- *BioMap: Guiding Land Conservation for Biodiversity in Massachusetts;* and
- *Living Waters: Guiding the Protection of Freshwater Biodiversity in Massachusetts.*

These three projects have been embraced by the conservation community of the state and are used continually to guide land protection and other activities relating to biodiversity protection. These projects are described in detail below.

Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts
In 1998 the NHESP, in cooperation with the Massachusetts Chapter of The Nature Conservancy -- and with funding from The Sweet Water Trust, the 1996 Massachusetts Open Space Bond Bill, and an anonymous donor -- took a close and in-depth look at biodiversity conservation in the

Commonwealth. The results of that study were published in *Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts*, an 84-page, full-color report, now out of print.

This report recommended that Massachusetts develop a Biodiversity Protection Strategy that would clearly outline how *all* native biodiversity would be conserved in the state. This Strategy would include the following actions:

- Encourage all conservation agencies, land trusts, municipalities, and not-for-profit conservation organizations to increase the importance given to and financial support for the conservation of uncommon and underprotected components of biodiversity;
- Educate landowners about maintaining and restoring certain natural processes and minimizing disturbance;
- Aid land managers in implementing land management techniques that mimic natural processes where they cannot be maintained or restored;
- Strive to achieve an equitable distribution of biologically viable conservation lands at all topographic elevations and across all ecoregions;
- Take action to conserve natural communities and species that have experienced tremendous loss or are under considerable threat; and
- Focus attention on natural communities and species, common or rare, which are underprotected.

The report also identified and described eight types of natural communities which require immediate conservation attention because of their vulnerability and the large number of rare species they contain. The eight natural communities identified were:

- Coastal Natural Communities
- Maritime Sandplain Natural Communities
- Coastal Plain Pond Communities
- Barrens Communities
- Riverine Communities
- Acidic Peatland Communities
- Vernal Pool Communities
- Calcareous Wetland Communities

Goals for biodiversity conservation for the years 1998 through 2008 were set as part of this planning process as follows:

- Conservation Planning and Inventory:
  - Complete inventories of all protected open space land to determine which components of biodiversity have been adequately protected.
  - Prepare a statewide Biodiversity Protection Strategy to conserve and guide management practices on protected lands.
- Land Acquisition:
  - Support the passage of the Community Preservation Act, which would provide money for land acquisition.
  - Continue to support new Open Space Bond Bill legislation.
  - Support initiatives designed to encourage land acquisition in Priority Habitats, such as financial incentives and transfer of development rights.

    - Set priorities for land acquisition according to the Biodiversity Protection Strategy. Until the strategy is formulated, state conservation agencies should focus on acquiring land within the three ecoregions with the largest diversity of rare species and threatened natural communities: Cape Cod and the Islands, the Connecticut River Valley, and the Western New England Marble Valleys.
- Biodiversity and Management:
  All environmental groups, municipalities, and non-profit conservation groups are urged to direct more conservation resources towards:
    - Restoring natural processes or implementing comparable alternative management techniques
    - Maintaining biodiversity by curbing abuses to open space lands from motorized vehicles and uncontrolled recreation, which is degrading many habitats and natural communities
    - Writing and implementing management plans that set priorities for biodiversity conservation and provide alternative sites for conflicting land uses

BioMap: Guiding Land Conservation for Biodiversity in Massachusetts
As a follow-up to *Our Irreplaceable Heritage*, the NHESP developed the BioMap, with funding made available by the Executive Office of Environmental Affairs, to identify the areas most in need of protection in order to protect the native biodiversity of the Commonwealth. The BioMap focused primarily on terrestrial and wetland state-listed rare species and exemplary natural communities, but also encompassed the full breadth of the state's native biological diversity.

The goal of the BioMap was to promote strategic land protection by producing a map showing the areas which, if protected, would provide suitable habitat over the long term for the maximum number of Massachusetts' terrestrial and wetland plant and animal species and natural communities.

In general, there are two primary components of biological diversity conservation. The first component is to identify and conserve elements of diversity (*e.g.*, populations, species, or natural communities) on protected areas; the second is to ensure continued functioning of the ecological processes that maintain these elements over time. The BioMap project addressed the first component by mapping habitat for identified populations of state-listed rare species (both plants and animals), as well as the locations of exemplary natural communities, and called these areas "Core Habitats." There were 129 rare animal species explicitly included in the BioMap, including 52 moths and butterflies, 25 damselflies and dragonflies, 10 beetles, 21 birds, 17 reptiles and amphibians, and 4 mammals (see Appendix A for a list of these species). In addition, bat hibernacula and habitat for suites of common animal species, such as forest-interior birds and coastal waterbirds, were also mapped during the BioMapping process. Specific habitats mapped for common bird species included the following natural communities:

- Spruce-Fir forest
- Northern Hardwoods-White Pine-Hemlock forest
- Transitional Oak-White Pine-Hemlock forest
- Pitch Pine-Scrub Oak forest
- Shrublands

- Sandplain Grasslands
- Cultural Grasslands
- Freshwater Emergent Marshes
- Forested Wetlands
- Salt Marshes
- Sandy Beach/Dunes
- Coastal Waterbird Nesting Island
- Coastal Shorebird Migration Habitat
- Songbird Migration Habitat

In order to increase the probability of persistence of these elements of biodiversity over time, a Geographic Information Systems model was used to create what was called "Supporting Natural Landscape" abutting Core Habitats. Supporting Natural Landscape is composed of some of the largest remaining patches of natural vegetation in the state, as well as undeveloped land immediately adjacent to the Core Habitats. This matrix of natural landscape should increase the probability of persistence of the targeted rare species and natural communities in Core Habitats in two ways:

- buffering Core Habitats against detrimental edge effects
- reducing fragmentation through coalescing separate Core Habitats into connected networks of natural landscapes.

The NHESP's specific conservation objectives for the BioMap project were as follows:

- Maintain viable populations of 435 state-listed rare taxa (plants and animals). Where possible, maintain populations throughout the statewide range of each species.
- Maintain viable examples of most natural community types.
- Maintain processes that have resulted in the biodiversity that exists today and that will allow it to persist into the future (these processes include reproduction, dispersal, and migration of individual species, as well as natural disturbance and successional processes for natural communities).
- Maintain ecosystem processes including nutrient and energy flow.

The BioMap identified 1,160,000 acres in Massachusetts as Core Habitat and 970,000 acres as Supporting Natural Landscape (see Figures 5 and 6).

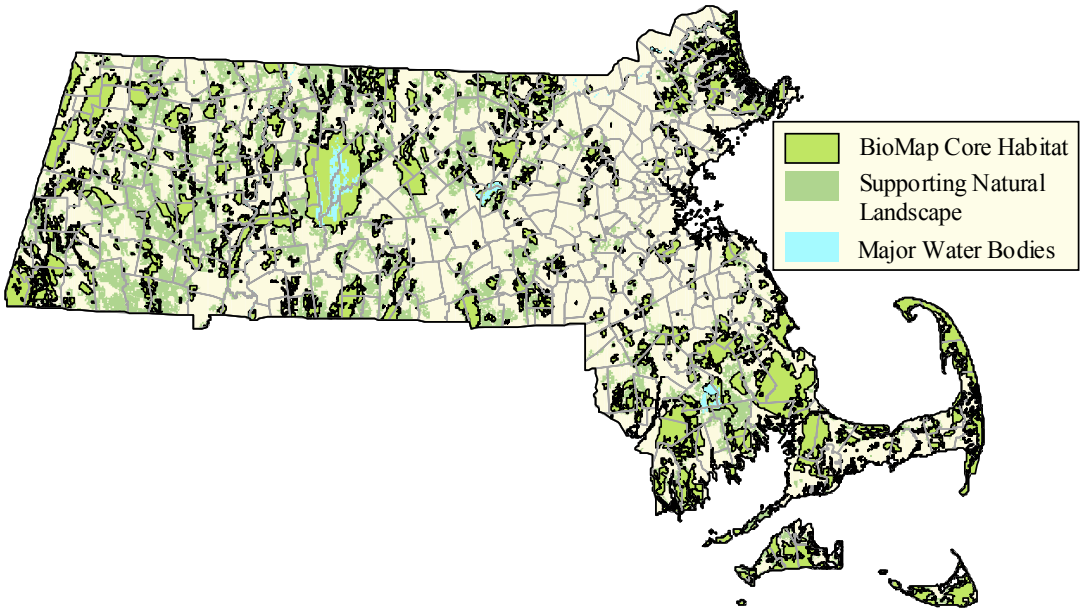

Figure 5: BioMap Core Habitats in Massachusetts.

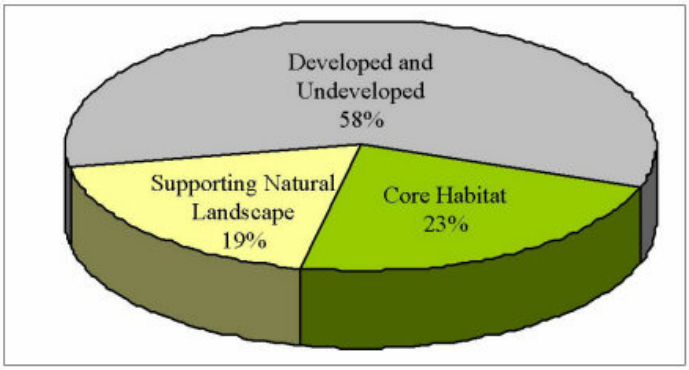

Figure 6: Percentage of Massachusetts' Acreage Identified as BioMap Core Habitat and Supporting Natural Landscape.

About 450,000 acres of Core Habitat (representing 9 % of Massachusetts; 39% of all Core Habitat) were considered protected when the BioMap was produced. Of the 970,000 acres of Supporting Natural Landscape, 210,000 acres were protected (representing 4% of Massachusetts; 22% of all Supporting Natural Landscape). See Figure 7.

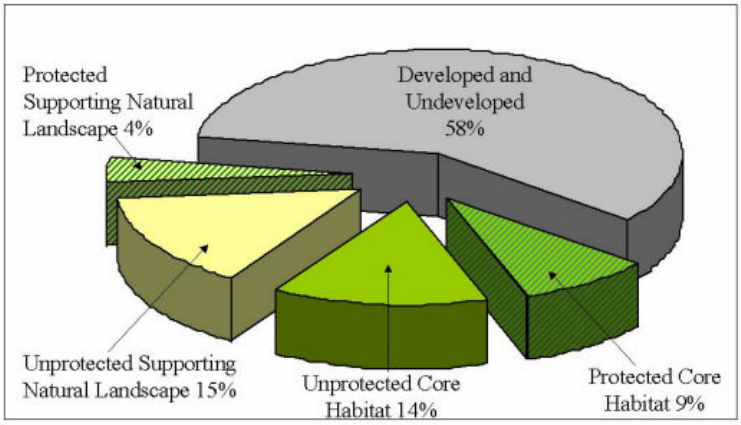

Figure 7: Percentage of Protected BioMap Core Habitat and Supporting Natural Landscape.

Although 660,000 acres identified on the BioMap are considered protected, there is still major effort needed to ensure the long-term protection of the state's biodiversity. Approximately 710,000 acres of the Core Habitat and 760,000 acres of Supporting Natural Landscape -- 1,470,000 acres in total -- remain unprotected. These areas represent the *highest priority* for biodiversity protection in Massachusetts.

Following the publication of BioMap, many conservation organizations in the Commonwealth used the BioMap "footprint" as a guideline for *their* land protection efforts. These organizations included:

- state agencies including the Division of Fisheries & Wildlife and the (now) Department of Conservation and Recreation
- national and state-wide non-profit organizations such as The Nature Conservancy, the Massachusetts Audubon Society, and The Trustees of Reservations
- regional land trusts such as the Wildlands Trust of Southeastern Massachusetts, the Essex County Greenbelt Association, the Mt. Grace Land Conservation Trust, the Opacum Land Trust, the Valley Land Fund, and the Berkshire Natural Resources Council
- municipalities, through their conservation commissions
- other groups, such as trails and greenway associations, watershed associations, and small local land trusts

These groups have seized upon the BioMap and its freshwater counterpart, the Living Waters project described below, as very useful and practical tools for helping to set land protection priorities.

BioMap Publications

- *BioMap: Guiding Land Conservation for Biodiversity in Massachusetts (2001)*
  This 60-page, full-color report describes the groundbreaking biodiversity mapping project the NHESP completed in 2001. It covers the impetus behind the project, describes major findings, and includes eco-regional maps with highlights from each ecoregion.

- *BioMap Technical Appendix (2001)*
  This 72-page supplement to the BioMap report covers the technical details of the project. It includes the criteria used to select species and natural communities for consideration, as well as details of the GIS analyses and a comprehensive list of references.

- BioMap Poster
  This full-color poster was produced in conjunction with the BioMap report and contains beautiful photos of some of Massachusetts rare species and natural communities.

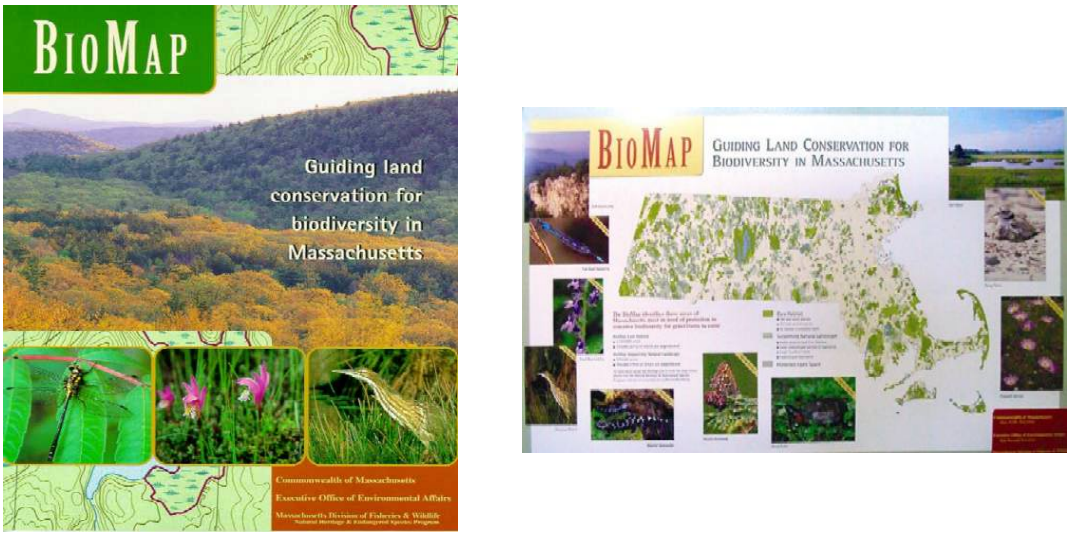

Figure 8: BioMap Report and Poster.

- BioMap Datalayers
  Two GIS polygon datalayers were developed and released to the public as part of the BioMap project: *BioMap Core Habitat* and *BioMap Supporting Natural Landscape.* The Core Habitat layer depicts the most viable habitat for rare species and natural communities in Massachusetts. The Supporting Natural Landscape areas buffer and connect Core Habitats, identifying large, naturally vegetated blocks that are relatively free from the impact of roads and other development. The quality of undeveloped land considered in the landscape analysis was evaluated based on four major components: natural vegetation patch characteristics; size of relatively roadless areas; subwatershed integrity; and contribution to buffering BioMap Core Habitats. These GIS datalayers are available for downloading from the Mass GIS website:
  http://www.state.ma.us/mgis/laylist.htm

Living Waters: Guiding the Protection of Freshwater Biodiversity in Massachusetts
In 2001, immediately after the BioMap project, the NHESP began the Living Waters project. The aim of this project was to identify, map, and formulate conservation priorities for the diversity of freshwater plants and animals in the Commonwealth. There is a great need to focus conservation efforts on freshwater species, because this group as a whole is among the most imperiled in the United States.

Produced with funding made available by the Executive Office of Environmental Affairs, the Living Waters project was designed to complement the BioMap. The BioMap presented conservation priorities for terrestrial, wetland, and estuarine biodiversity, and included upland plants, animals, and natural communities, as well as many partially aquatic groups like salamanders, turtles, dragonflies, damselflies, water birds, emergent wetland plants and wetland natural communities. In contrast, the Living Waters project focused on freshwater species that spend all or a substantial portion of their life cycle underwater. These species included aquatic vascular plants, 11 species of rare fishes, and 24 species of aquatic invertebrates including freshwater mussels, crayfish, and snails. See Appendix C for a list of the animal species included.

In the Living Waters conservation plan, Core Habitats in lakes, ponds, rivers, and streams that are key sites for freshwater biodiversity conservation were again identified. The Core Habitats were identified based on the documented habitats of rare freshwater species and on locations of exemplary aquatic habitats. Both the terminology used in the Living Waters project, and the methodology on which it is based, parallel those used in the BioMap. All Core Habitats identified by the NHESP represented the highest priority sites for biodiversity conservation in Massachusetts given our state of knowledge at that time. Living Waters Core Habitats can and should be used to guide watershed management as well as to inform land protection, particularly in riparian areas, while those in the BioMap are intended primarily to help prioritize land conservation.

The goal of the Living Waters project was to promote the strategic protection of freshwater biodiversity in Massachusetts through the assessment and mapping of rare aquatic species and their habitats, as well as exemplary aquatic systems. To accomplish this goal, the NHESP:

1. Collected, compiled and analyzed existing resources and data sets pertaining to freshwater biodiversity in Massachusetts.
2. Identified and targeted sites for field inventories to improve knowledge of the status and distribution of aquatic biota and ecosystems.
3. Mapped known habitats of rare aquatic species and other exemplary aquatic habitats, as well as the critical portions of their associated watersheds.
4. Created tools to educate citizens and guide conservation efforts, which included:
    - a conservation map and accompanying report
    - Geographic Information Systems (GIS) datalayers
    - associated materials such as brief fact sheets for many of the individual rare aquatic species and a field guide to the dragonflies and damselflies of Massachusetts.

Unlike terrestrial habitats, there is no standard aquatic community classification framework to use as a basis for identifying exemplary natural communities in freshwater systems. Instead, natural community Core Habitats that were likely to support important elements of aquatic biodiversity were selected based on current biological, chemical, or physical information. Multiple approaches were taken to identifying these exemplary habitats. The analysis was based on datasets from native fish communities found in inland and coastal streams, aquatic invertebrate communities of small streams, rare invertebrates of flowing waters, and information

on aquatic plants, aquatic invertebrates, and water chemistry of the lakes and ponds of Massachusetts.

All of the Core Habitats that were identified through both rare species and natural community analyses were merged together to produce a total of 429 final Living Waters Core Habitats. These Core Habitats include about 1000 miles of rivers and streams, and 247 lakes and ponds. Twenty-four percent of the upland within 100 meters (the riparian area) of Living Waters Core Habitats is already protected.

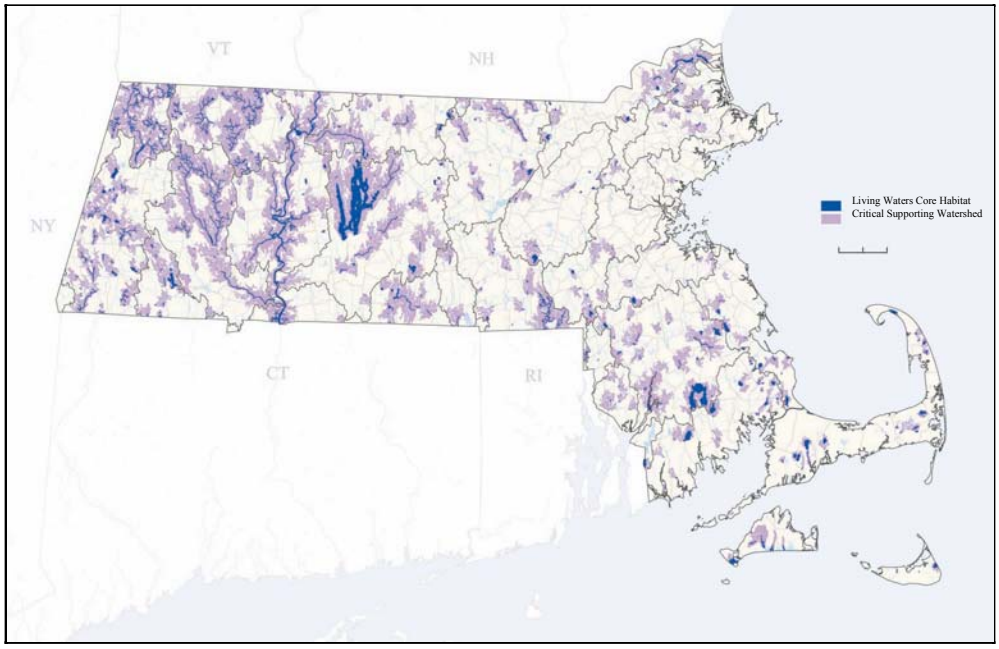

Figure 9: Living Waters Core Habitats.

However, identifying only 100 meters upland from each Core Habitat is likely not sufficient for the protection of aquatic biodiversity for two main reasons. Most importantly, many of our Core Habitats do not have a continuous riparian forest buffer and therefore are already being directly impacted by the effects of impervious surfaces, agriculture, sedimentation, and point sources of pollution in the 100-meter riparian area. Until naturally vegetated riparian buffers are created, sound management practices in these adjacent areas are needed in order to protect aquatic habitats. While all activities within a watershed have the potential to affect a Core Habitat, those sections of the watersheds that are closer to the Core Habitat are the most critical. To direct conservation activities to these critical portions of a Core Habitat's watershed, the concept of the Critical Supporting Watershed was developed as part of the Living Waters project. Specifically, the Critical Supporting Watershed is defined as, "the more immediate portion of a Core Habitat's watershed with the greatest potential to sustain or degrade the aquatic habitat."

The Critical Supporting Watershed boundaries were created with a Geographic Information Systems (GIS) model developed especially for this project in conjunction with the University of Massachusetts. For details on this model, see the technical report for the Living Waters project.

The Critical Supporting Watershed in Massachusetts encompasses 1,380,000 acres of undeveloped and developed land.

Living Waters Publications

- *Living Waters: Guiding the Protection of Freshwater Biodiversity in Massachusetts (2003)*
  This 50-page, full-color report describes the creation of the NHESP's conservation plan for the state's freshwater plants, fish, and invertebrates. It includes an introduction to freshwater species and their conservation needs and provides detailed watershed-based maps with species highlights from each region.

- *Living Waters Technical Report (2003)*
  This supplement to the Living Waters report details the scientific and GIS methods used in creating the conservation plan. This document is intended for a technical audience.

- Living Waters Poster
  This colorful poster showcases the Living Waters conservation plan. It contains beautiful photographs of some of Massachusetts' rarely seen underwater species.

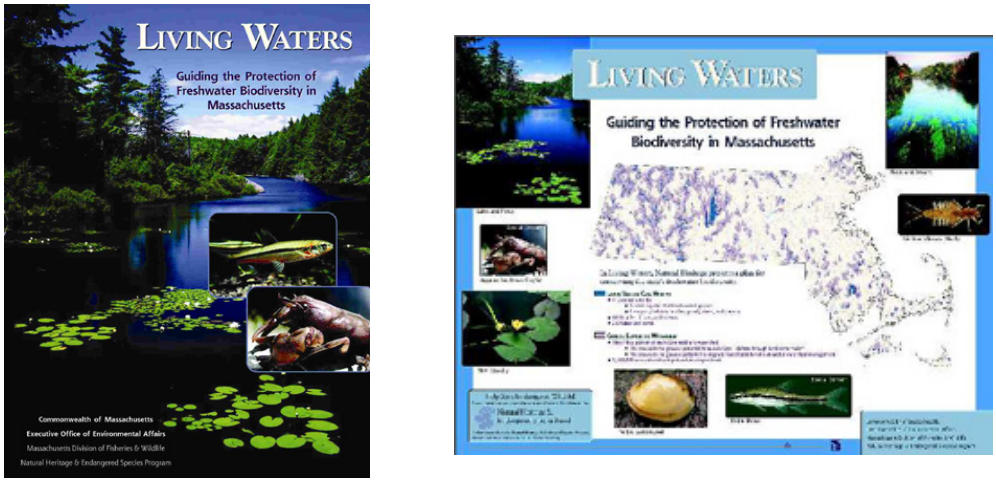

Figure 10: Living Waters Report and Poster.

- Living Waters Datalayers
  Two GIS polygon datalayers were developed and released to the public as part of the Living Waters project: *Living Waters Core Habitats* and *Critical Supporting Watersheds*. Living Waters Core Habitats represent lakes, ponds, rivers, and streams that are important for the protection of freshwater biodiversity in Massachusetts. The Critical Supporting Watersheds are those areas with more immediate hydrologic contributions to Living Waters Core Habitats. As such, they represent the areas with the highest potential to sustain or degrade Core Habitats. These datalayers are available for downloading from the MassGIS website at **http://www.state.ma.us/mgis/laylist.htm**.

2. Wildlife Section

Structure and Function
The Wildlife Section oversees research and management of all avian and mammalian species within the Commonwealth of Massachusetts that are primarily utilized in any way for meat, fur or sporting purposes, and is also responsible for the MDFW's sustainable forestry program and upland habitat program on over 100,000 acres of state wildlife management areas. The overall program goal is to promote biodiversity and conserve the Commonwealth's game species, and more specifically, to maintain their populations at levels in balance within the biological carrying capacity of their habitat and the cultural carrying capacity of the public.

While the Wildlife Section is devoted primarily to research and management of wildlife populations of species that are hunted or trapped, as well as active habitat management, it is also responsible for the MDFW's pheasant stocking program, the testing and registration of problem animal control (PAC) agents and falconers, and the licensing and inspection of commercial deer farms and certain other propagators.

The Wildlife Section has a staff of wildlife biologists and foresters who conduct research and management projects throughout the state with assistance from District personnel and in cooperation with the U.S. Fish & Wildlife Service and the Massachusetts Cooperative Fish & Wildlife Research Unit (USGS). Biologists and foresters within the Wildlife Section engage in wildlife management programs under the following general classifications:

- Monitoring of wildlife populations and habitat
- Community-based human-wildlife conflict management
- Restoration of wildlife
- Basic ecological research
- Public use and methodology surveys
- Sustainable forest management
- Early-successional habitat management
- Habitat protection

MDFW biologists participate, to the extent possible and practical, in the Northeast Technical Committees, the Atlantic Flyway Council, the Eastern Black Bear Workshop, the North American Moose Conference and Workshop, the Northeast Fish and Wildlife Conference, the Society of American Foresters, and other professional meetings. This participation is one step in fostering regional and national partnerships. At a state and local level, MDFW biologists frequently engage with stakeholders such as private, public, and non-profit entities and individuals in community-based wildlife issues.

From a regulatory and policy perspective, the Massachusetts Division of Fisheries and Wildlife Board has the authority to create or modify regulations governing the harvest of game species. The Board relies on the Wildlife Section to provide biological information that can be used to formulate recommendations for regulatory actions. This assures the Board and the public that wildlife is managed based on scientific information. Each regulatory action, such as a change in season length or bag limit, requires a public hearing, at which time the Board can weigh the

Wildlife Section's recommendations and the stakeholder perceptions and values – a public process backed by the science of wildlife management.

General Perspectives and Challenges

Context: Many of the projects within the Wildlife Section address particular species, groups of species, or species-specific habitats or issues and relate to projects and activities encompassing regional, national, or global issues and interests. This viewpoint comprises a holistic perspective of wildlife conservation and management (Hamilton 1999), and the projects within the Wildlife Section may be construed consistently with such a perspective. The Wildlife Section further offers the following general perspectives and challenges facing wildlife management today.

Management Perspectives: Fisheries and wildlife conservation and management should be viewed as comprising a triad of essential, mutually supporting components: (1) an organism or group of organisms, (2) habitats or communities, and (3) interest groups (Giles 1978:10). The traditional approach has focused largely on the organisms, less so on the habitat, and infrequently so on human dimensions. Many, if not most, past investigations have been pursued in quasi-isolation and with little attention to broader perspectives and issues. However, in order to meaningfully project natural resources conservation into the 21st century, fisheries and wildlife programs must address all facets of the triad. Habitat protection and management must complement species-specific investigations, and the viewpoints and needs of stakeholders must be understood and integrated into management plans. Failure to do so may well result in the failure of the wildlife management profession to successfully promote its programs, and meet its challenges, during the coming decades.

Ecosystem Management: Ecosystem management (EM) asks stewards to manage lands for commodities, amenities, and native biological diversity (Knight 1999) consistent with Aldo Leopold's historic "land ethic." Grumbine (1994) argued that EM was a new, fundamental reframing of how humans worked with nature. He set forth ten dominant themes which comprise EM and proposed five specific goals: (1) maintaining viable populations, (2) ecosystem representation, (3) maintaining ecological processes, (4) protecting the evolutionary potential of species and ecosystems, and (5) accommodating human use in the context of the above. He later (Grumbine 1997) reviewed our knowledge of the ten themes and suggested that momentum for EM is growing. Grumbine challenged those who do not support this change (to an EM focus) to describe a sustainable alternative. Fuller and Organ (1997) also promoted EM and urged states to increase inter-agency coordination to manage species on large scales. Such partnerships and pooling of limited resources can provide more efficient, progressive, and fruitful outcomes to wildlife conservation issues and problems through increased cost-efficiency, greater problem-solving ability, and liberation from a rigid command and control approach (Fuller and Organ 1997, Knight and Meffe 1997). The MDFW, with and through the Executive Office of Environmental Affairs, is actively promoting the biodiversity of the Commonwealth (Barbour et al. 1998) and seeks to integrate and expand its management activities through appropriate conservation partnerships (Sample 1995, Duda et al. 1998).

Human Dimensions: Fisheries and wildlife management is experiencing a fundamental philosophical shift away from a solely sportsman-based clientele (Hogarth 1934) to one involving all "stakeholding" citizens (Decker et al. 1996). Muth et al. (1998) surveyed the attitudes and options of fish and wildlife professionals and identified shared areas of agreement

as well as points of disagreement. Our understanding of these attitudes, values, and perspectives is essential to forging a coalition that speaks proactively and effectively. Decker and Enck (1996) identified four contemporary concerns for wildlife management agencies to survive and flourish in the 21st century: (1) identify and understand diverse stakeholders, (2) understand the forces affecting traditional stakeholder participation, (3) assess the best ways to obtain stakeholder input for management decisions, and (4) determine how to integrate stakeholder input into management decisions. Guynn and Landry (1996) supported this approach, and described a successful example. Duda and Young (1996) observed that the public supports environmental conservation, and argued that to be effective the leadership must listen to the governed. Angermeier (2000) warned that conservationists must reach consensus on their basic values and goals and convince society to accept them. The effective melding of such human dimensions approaches with traditional wildlife management is intrinsic to future program success.

Challenges: A principal early challenge of wildlife conservation and management was to recover and restore depleted game populations (Leopold 1933). To a substantial degree, this challenge has been met (Kallman 1987). Significant challenges for the 21st century include the following (among others):

Habitat Loss and Degradation. It is axiomatic that organisms are dependent on suitable habitat: creatures need nutrients, water, shelter, and other habitat features in order to survive. Enormous losses and tremendous degradation of natural habitats and biotic communities has occurred and is escalating (Noss and Murphy 1995). Chief among Diamond's (1982) "evil quartet," habitat destruction is now the major cause of species endangerment (Noss and Murphy 1995). Eastern forests have been drastically altered by 400 years of human habitation and exploitation (D. Foster 1995, McWilliams et al. 1997, C. Foster 1998). Habitat fragmentation (Wilcove et al. 1986, Shafer 1990) reduces key habitat features, hinders dispersal and gene flow, and renders isolated populations vulnerable to over-exploitation, predation, disease, edge effects, and competition with invasive exotics. Public roadways dissect the landscape and have an ecological effect on 1/5 of the land area of the U.S. (Forman 2000). In eastern Massachusetts, road effects extended outward >100 m for all factors and >1 km for moose corridors, road avoidance by grassland birds, and possibly road salting in a shallow reservoir (Forman and Deblinger 2000). Some communities in the Northeast – particularly grasslands (Askins 1997), coastal plain ponds, barrier beaches and heaths (Barbour et al. 1998), and early successional habitats (Litvaitis et al. 1999) – are especially threatened. Deforestation and long-term climatic changes (i.e., global warming) (Bradley et al. 1987, McDowell et al. 1990, Gardiner 1998, Lemonick 2000) and other human activities (Kerr and Currie 1995) are forcing shifts in the distributions of plants and animals which bode poorly for earth's ecosystems. These unprecedented threats demand regional, national, and international cooperation in ecosystem management (see above). Nature is ever-changing and inconstant, especially in view of human perturbation; we will need to manage natural communities to save them (DeGraaf and Healy 1993).

Socio-economic Factors: Uncontrolled human population growth (Torrey 1993, Gehrt 1996) is the untamed dragon which threatens the viability of the planet to sustain itself. It is one of the greatest threats – if not *the* greatest – to biodiversity and to human survival. Despite falling fertility rates, the global population is expected to reach 7.3 to 10.7 billion by 2050 (Kluger 2000). Czech (2000) argues that economic growth is the limiting factor affecting wildlife

conservation. He suggests seven principles, including the point that humans must organize and limit their economic capacity before reaching [human] carrying capacity; the closer to carrying capacity, the more wildlife species will be lost.

Human Dimensions: Manfredo et al. (1998) discussed several key issues and challenges for human dimensions research including a philosophical orientation within the context of wildlife management; broad-ranging dissemination of information; the need for studies of long-term or recurring problems; a requirement for regional collaborations; and expanding the utility of human dimensions data. While often frustrating, the social aspects of wildlife management will only grow more intense as we proceed into the 21st century, driving the need for further investment in human dimensions. Wildlife management by ballot box (Beck 1998, Minnis 1998, Deblinger et al. 1999) has burgeoned in the past decade (Williamson 1998a). The counter to these citizen initiatives may lie in implementation of the stakeholder concept (Decker et al. 1996); fostering partnerships and public involvement and participation in decision-making (Guynn and Landry 1997, Duda et al. 1998); listening to, rather than dictating to, the governed (Duda and Young 1996); raising voter awareness and protecting against special interests (Williamson 1998b); and attaining a consensus on fundamental concepts and values among professionals and effectively persuading constituents to adopt them (Angemeier 2000). In particular, effective communication procedures must be in place well before any ballot initiative is filed (Williamson 1998b). After a petition is underway, emotions and funds, rather than fact, may drive the process.

Exotic Organisms and Diseases: The pernicious effects of exotic organisms have been addressed by Balon and Bruton (1986), Soule (1990), Temple (1990), and Coblentz (1990), among others. Exotic species may prey upon, hybridize with, or compete with native animals and plants, depredate or defoliate agricultural crops or forests, introduce diseases or parasites, and impede or deplete water supplies. The introductions and effects of exotic organisms within Massachusetts have been reviewed by Cardoza et al. (1993), Jones and Cardoza (1997), and Hellquist (1997), among others. While the MDFW's statutes, regulations and policies are relatively strict regarding importation, possession and release of exotic species, substantial authority regarding invertebrates and plants is lacking. Inadvertent, accidental, or illegal releases, translocations, or range expansions continue to pose a threat to the biodiversity of Massachusetts. Exotic diseases (Cunningham 1996, Daszak et al. 2000) are a growing threat in the face of global economics and rapid intercontinental transportation.

Ethics: Biologists and managers cannot ignore the necessity of ethics in wildlife conservation and management. While an essential distinction must be made between “animal welfare” and “animal rights,” the ultimate responsibility devolves upon wildlife professionals to understand their ethical responsibilities (Neave 1993, Friend et al. 1994, Manville 1994, Peck and Simmonds 1995, Bekoff and Jamieson 1996, Organ et al. 1998) and to inculcate such practices and standards into their research and management activities. Protocols for the field study and research of black bear (Cardoza 1991a), wild turkey (Cardoza 1991b), and white-tailed deer and moose (Cardoza 1992) have been approved by a MDFW Animal Care and Use Committee. When applicable under the U.S. Animal Welfare Act, similar protocols should be prepared and approved for intrusive studies of other species.

Long-Term Research: To the extent possible and practical, field and research studies should take a long-term approach (Leopold et al. 1996, Krausman and Bolen 1996, Pelton and van Manen 1996). Short-term studies can be misleading for long-lived species, stochastic environmental variables may not be encountered in the short term, and decision-making models are modified and refined over time. Estimates of effective population size necessary for adequate population viability assessment may also require a long-term series of annual counts (Vucetich and Waite 1998). Problems in long-term research and monitoring include maintaining funding, consistency, and creativity; finding suitable long-term study areas; maintaining continuity with cooperators; and dealing with large data sets (Pelton and van Manen 1996).

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Recent Projects

Sustainable Forestry on Massachusetts State Wildlife Lands

The Massachusetts Division of Fisheries and Wildlife's (MDFW) statutory responsibility provides for the conservation (including protection, restoration, and management) of Massachusetts flora and fauna (Darey and Jones 1997). Species of flora and fauna rarely exist in isolation, but rather occur in assemblages, or natural communities. In turn, each natural community dynamic is driven by ecosystem processes, such as natural disturbances, nutrient cycling and energy flow. This interaction between the complex of species, natural communities, and ecosystem processes represents the MDFW's working definition of biological diversity, or "biodiversity". The conservation of biodiversity is a fundamental component of the MDFW's Sustainable Forestry Program.

While the concept of a biodiversity-based approach to forest management is relatively new, the basis for this concept was established within the forestry profession long before the term "biodiversity" was coined. In 1917, Gifford Pinchot (the first Chief of the U.S. Forest Service) noted that "The forest…takes its importance less from the individual trees which help to form it than from the qualities which belong to it as a whole" (Miller and Staebler 1999). Despite the fact that intensive use of forest resources has occurred in Massachusetts for nearly 300 years (Foster et al. 1998a), the concept of sound forest management was established in the Commonwealth less than 100 years ago with the passage of the Massachusetts Reforestation Act in 1908 (Rivers 1998). It is widely accepted that the post-European settlement view of forests as commodities to be exploited led to a dramatic and drastic alteration of the forest landscape throughout Massachusetts during the 18th and 19th centuries (Foster et al. 1998a). This alteration obscured regional forest patterns that corresponded to climate, substrate, and fire regime (Foster et al. 1998a, Fuller et al. 1998). Today, forest management must continue to evolve to include not just trees, but all aspects of the forest environment, including shrub, herb, soil, and wildlife communities. This evolution is essential as managers struggle to balance increasing human demand for wood products with the pressing need for biodiversity conservation.

The goal of the MDFW's Sustainable Forestry Program is to provide a full range of forest successional stages in order to maintain native species, natural communities and ecological processes while addressing various cultural concerns, including public recreation and wood production (Scanlon et al. 2000). The MDFW does not advocate returning forest condition to any previous point in time, but rather advocates driving the future forest condition to achieve important biological and cultural goals. The agency recognizes that availability of early-seral forest habitat has declined dramatically over the last several decades, and that late-seral forest habitats are exceedingly rare in Massachusetts today (Figure 11). Management for early- and late-seral forest habitat is a cornerstone of MDFW forest management policy.

The MDFW maintains that it is possible and desirable to accommodate a variety of cultural demands on its 125,000 acres of state wildlife lands, including traditional uses such as non-motorized public recreation and production of renewable wood products.

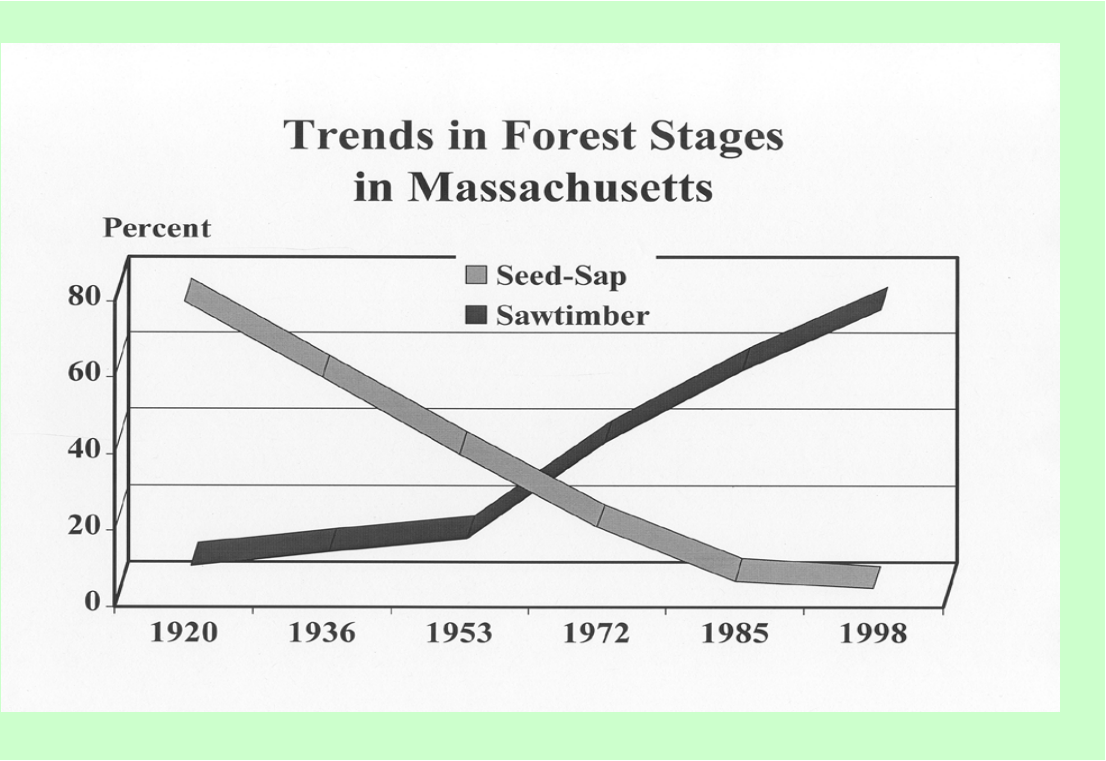

Figure 11: General Trends in Forest Stages on Massachusetts Forestlands.

Massachusetts is a net importer of wood products, and current harvests of timber and fuelwood from Massachusetts forestlands are equivalent to only 6% of annual per capita wood consumption in the state (Berlik 1999). Not only does Massachusetts import the great majority of the wood it uses, but that importation invariably utilizes fossil-fuel based transport which adds air pollutants to our atmosphere, and which may contribute to global warming. While recycling and conservation of wood products are to be encouraged at all levels, the renewable qualities of wood should make it a resource of choice over non-renewable fossil fuels. Yet, "To the average citizen, the prospect of harvesting trees triggers instant environmental concern notwithstanding the fact that carefully managed forests tend to provide more uses, values, and benefits than those lacking responsible stewardship actions." (Foster and Foster 1999:9). Comprehensive baseline inventories combined with subsequent biological monitoring of species and communities on both actively managed lands (e.g., where harvest of wood products occurs), and on passively managed lands (e.g. forest reserves) will be used to verify that the MDFW is meeting its biodiversity conservation goal.

Sustainable management of timber, wildlife, and water resources is critical to maintaining public confidence in the oversight of state-owned forestlands. Forest (aka "Green") Certification provides independent, third party verification that forestry practices on state-owned lands in

Massachusetts are economically, ecologically, and socially sustainable. Massachusetts is the first state in the Nation to have all of its public forestlands receive Forest Stewardship Council (FSC) certification (see http://www.fscus.org/newsletters/FSCNews_jun_2004.pdf). The FSC (www.fscoax.org) is widely recognized as the most credible provider of third-party certification of the sustainability of forest management practices.

The Landscape Context

Forest ownerships do not exist in isolation, but are part of the larger landscape. Even though WMA forestlands account for <3% of commercial forestland in Massachusetts, they should not be managed as discrete entities, but rather as integral parts of regional landscapes. Even-aged forests that now dominate the Massachusetts landscape are the result of historic land use practices and farm abandonment (Litvaitis 1993, Foster et al.1998a). Various bird and mammal species commonly associated with early-seral habitats have declined consistently since the 1950s in response to the limited availability of these habitats (Hill and Hagan 1991, Litvaitis 1993). This reduction in the number of early-seral bird and mammal species represents a trend that may be extended in space and time beyond the previously described effects of forest maturation. Current land uses fragment and isolate habitat patches, thus potentially reducing the viability of some local populations.

Preserving biodiversity in temperate forest regions requires maintenance of all seral stages across the landscape, including the creation of early-seral habitats and the preservation or re-creation of late-seral or old-growth forests (Franklin 1988). Therefore, in order to maintain biodiversity, the management of DFW forestlands requires the designation of some natural ecosystems as forest reserves (areas that are not subject to wood products extraction) as well as commodity production in modified, semi-natural (managed) ecosystems (Hunter 1996, Irland 1999). Successful strategies for conservation of biological diversity in temperate forest regions must effectively address the designation of networks of reserves as well as a managed forest matrix (Lindenmayer and Franklin 1997).

Forest Composition Goals

Vertebrate wildlife species in New England have been well studied and benefit when primarily forested landscapes contain a mix of forest size classes, generally 5-15% seedling/regeneration (or early-seral forest), 30-40% sapling-pole, 40-50% sawtimber, and <10% large sawtimber (DeGraaf et al. 1992:17and DeGraaf et al. 2005:82). Invertebrate wildlife species are generally less well studied, and knowledge of their habitat requirements is incomplete.

MDFW has determined that the establishment of some late-seral forest habitat is warranted to meet its biodiversity conservation goal. Late-seral forest is defined as having attained >50% of its maximum expected biological age. Many tree species native to Massachusetts such as Eastern hemlock, northern red oak, American beech, and sugar maple can live >300 years, so late-seral forest habitat is loosely defined to be >150 years old. Late-seral forest is uncommon throughout New England today because trees generally reach economic maturity long before they reach biological maturity (60-90 years, vs. 150-300 years, respectively). To approximate a natural landscape age structure in New England, a portion of forest area should reach 300 years of age (Seymour and Hunter 1999).

Landscape composition goals for MDFW forestlands currently include 15-20% early-seral (seedling, sapling & small pole) forest, 65-75% mid-seral (large pole and sawtimber) forest, and 10-15% late-seral forest (Figure 12). Currently, forestlands on WMAs are nearly exclusively mid-seral, with only about 2% early-seral forest, and <1% late-seral forest.

MDFW creates early-seral forest habitat through publicly bid, commercial timber sales that provide renewable wood products which help sustain rural economies. MDFW plans to meet its goal for late-seral habitat by establishing forest reserves on 10-15% of its lands where commercial harvesting will not occur. Natural disturbance processes will largely determine the structure and composition of the forest ecosystem in reserves, while sustainable harvesting will largely determine structure and composition of actively managed forestlands. Reserves function as "controls" for "treatments" applied to harvested sites, and provide a critical yardstick for evaluating results of biological monitoring on harvested sites. Reserves will provide unique recreational opportunities for people, and may provide unique habitat for invertebrate species of wildlife, including those that utilize large woody debris.

Harvested sites provide diverse forest structure through retention of some overstory trees on all sites. Retention harvesting is based on the understanding that biological legacies -remnants of the previous forest ecosystem - persist following a natural disturbance event (Foster et al. 1998b). Patches of forest of various sizes (generally 0.1-0.25 ac) and shapes, which are representative of initial stand composition, are retained during all harvests on MDFW lands. Retained patches include large live trees, large cavity-bearing trees, understory shrubs, and large downed logs. Patch retention on harvested sites can maintain abundance of cavity-nesting birds (Gunn and Hagan 2000), and provides cool, moist microhabitats for various amphibians (Dupuis et al. 1995).

Sustainable harvesting is critical to meeting MDFW goals for biodiversity conservation. Reserves help to validate the sustainability of harvesting, and insure that the full diversity of forest successional stages occur on the landscape. The prudence of retaining all components of a landscape was perhaps best expressed by Aldo Leopold in 1953, who stated that "If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering" (Leopold 1972).

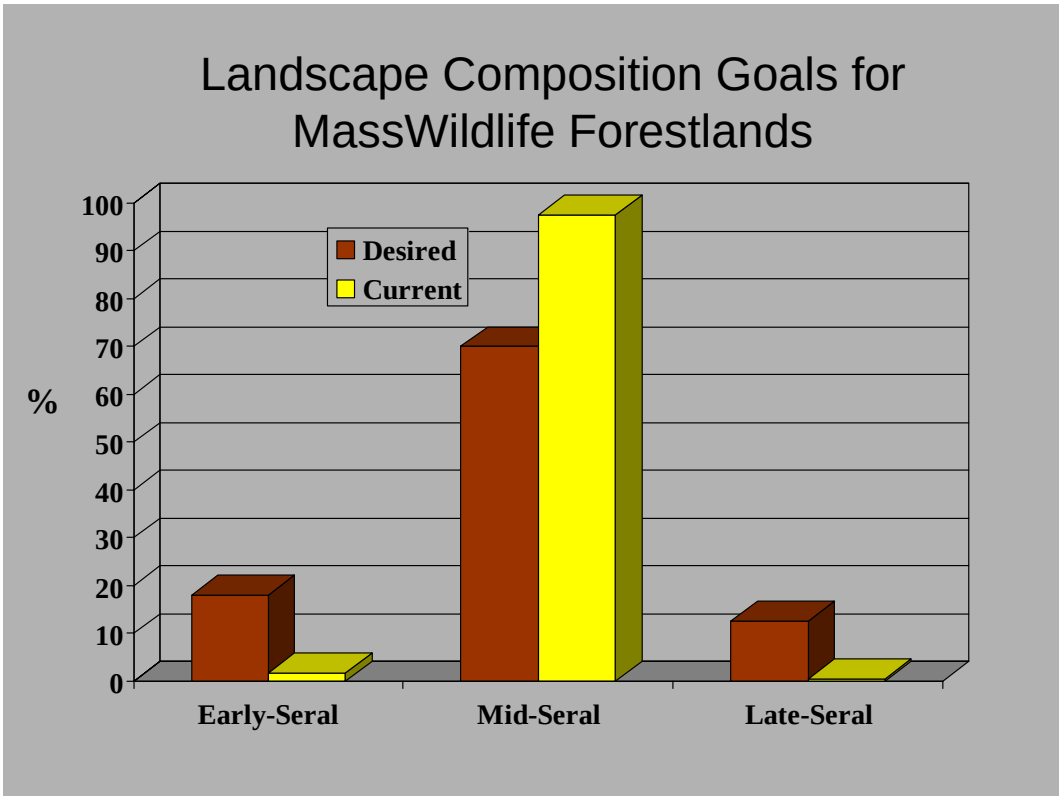

Figure 12: Current vs. Desired Distribution of Forest Stages on Wildlife Management Areas.

The Management Process

Ecoregions and watersheds provide the spatial framework for all MDFW forest management decisions. Ecoregions are defined as portions of the landscape where vegetation, soils, landform, and climate are relatively similar. The MDFW has adopted the U.S. Forest Service Ecological Units framework (Keys et al. 1995) for delineation of 14 ecoregions within Massachusetts (Figure 13). Within an ecoregion, MDFW properties are grouped into individual management units that are defined by portions of major watersheds within the ecoregion (Figure 14). This approach fosters management at a landscape level, and allows non-point source pollution issues to be addressed for several MDFW properties in a single plan. A total of 50 forest management units encompass the 125,000 acres of MDFW lands (Figure 15).

All planned silvicultural treatments within a management unit plan are reviewed internally by both the Natural Heritage & Endangered Species Program and by the appropriate regional MDFW District office. After internal review is completed, a Chapter 132 forest cutting plan is submitted to the Massachusetts Department of Conservation and Recreation, and a timber sale contract is completed through a public bidding process. High priority sites for silvicultural treatment include plantations and forest stands that were subjected to high-grade timber cutting prior to MDFW acquisition.

High-grade cutting (cutting of individual, high quality timber trees and retention of poorly-formed trees of low vigor) is a problem throughout Massachusetts (Mauri 1998). High-grade

cutting not only reduces future economic value of forestland, but also reduces current and future acorn (mast) production. Oak generally fails to regenerate after high-grading because the selective removal of high-value trees fails to provide adequate sunlight for the survival of oak seedlings.

The oak genera provide the greatest amount of mast for wildlife in southern New England. Oaks and acorns play a fundamental role in the organization and dynamics of eastern wildlife communities, and these relationships have been developing for millennia (Healy et al. 1997:251). Oak forests are generally not regenerating successfully in the northeastern U.S. on mesic sites amenable to growing oak, and are gradually being replaced by more shade tolerant red maple and black birch (*Betula lenta*) (Lorimer 1993 and Healy et al. 1997). This is true in Massachusetts, where red maple and black birch are increasing in number (Alerich 2000).

Silvicultural treatments on MDFW forestlands retain high quality mast-bearing trees for seed, and remove low value trees that lack desirable habitat attributes (e.g., cavities, den sites, or nest sites). This approach creates extensive, structurally diverse stands across a range of seral forest stages. MDFW land managers strive to incorporate

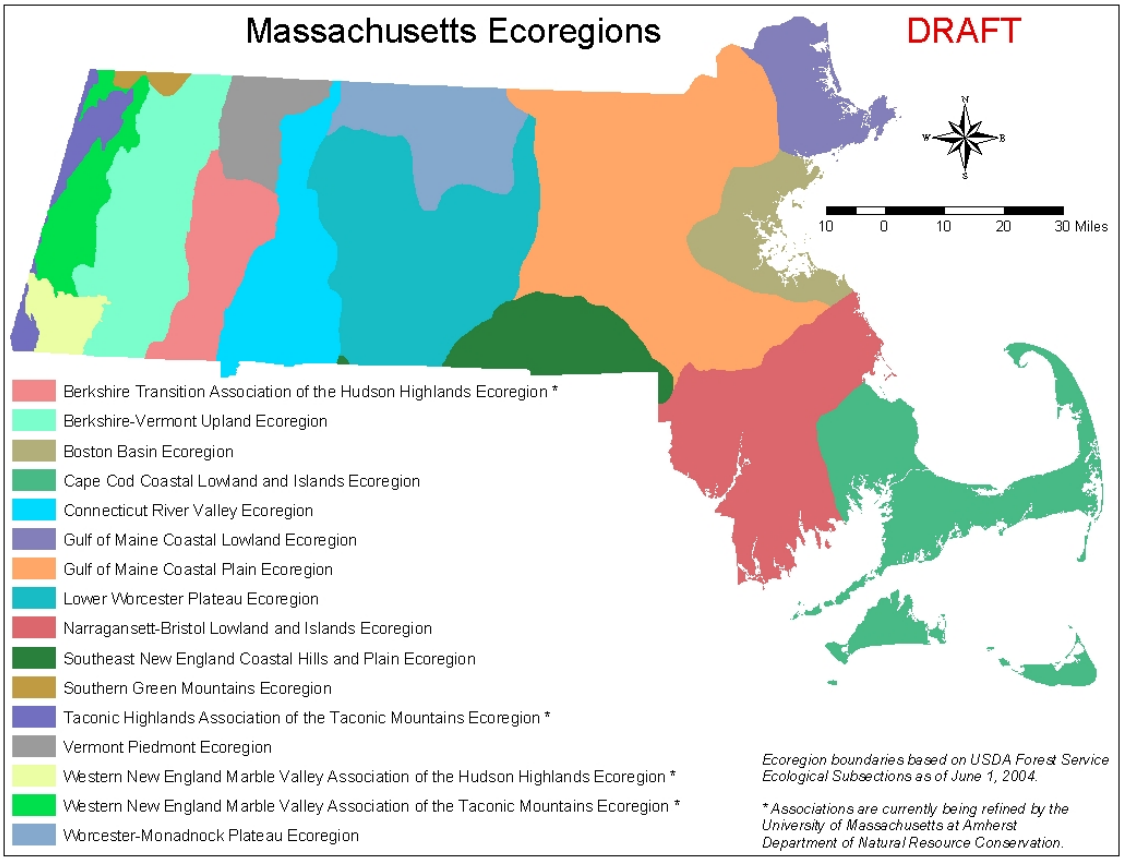

Figure 13: Massachusetts Ecoregions.

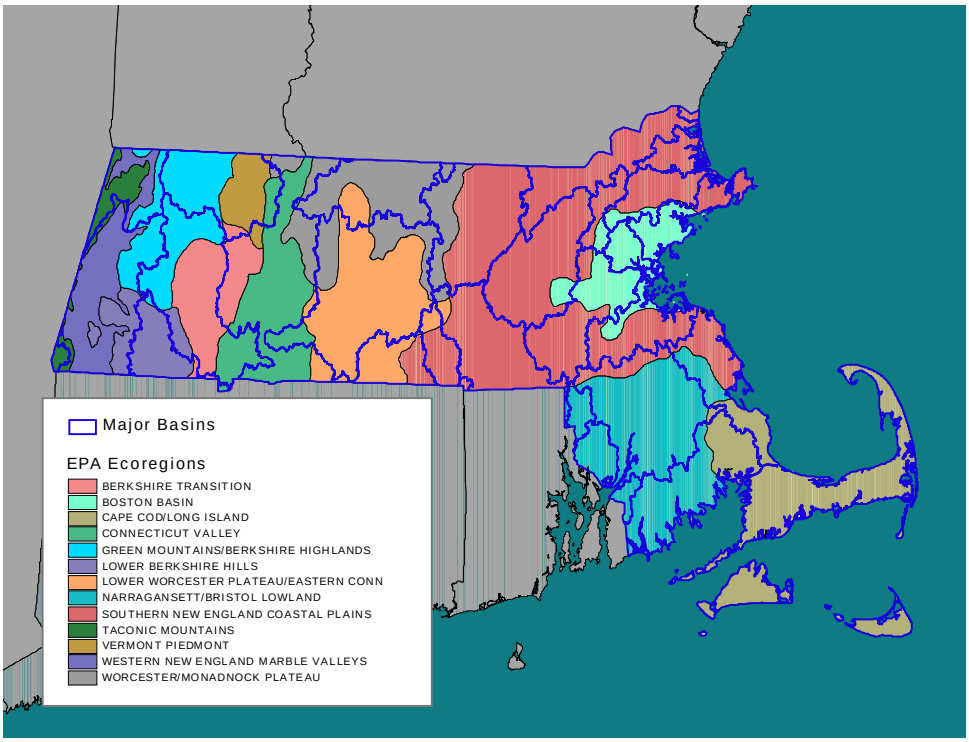

Figure 14: Massachusetts ecoregions and major watershed boundaries.

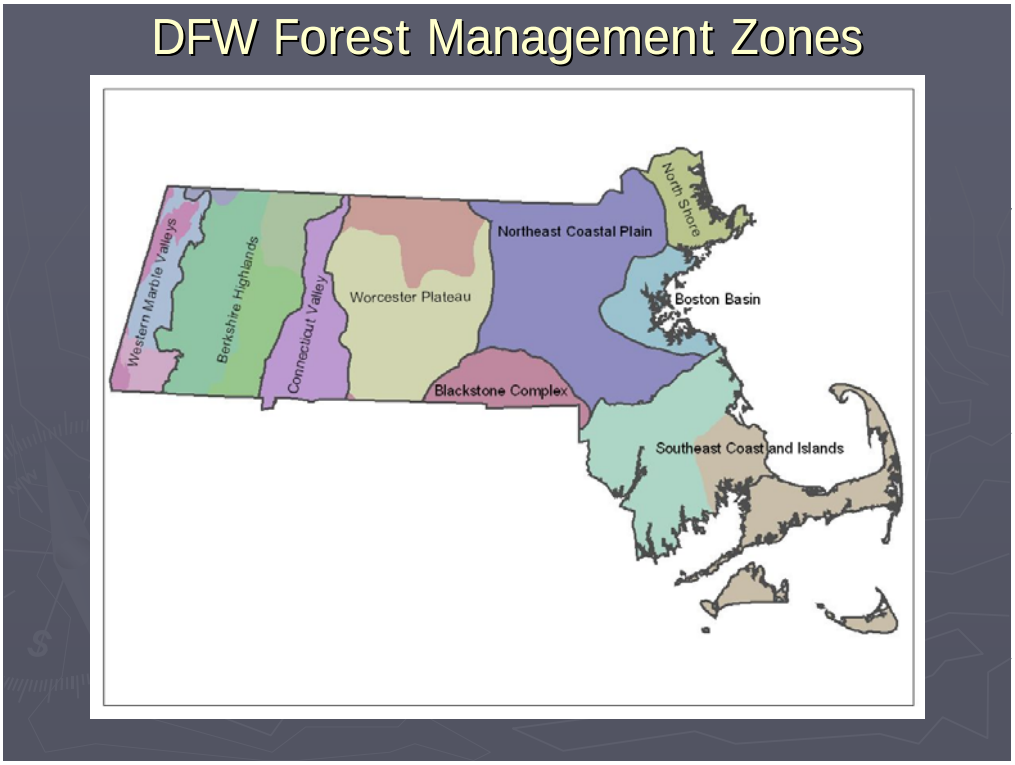

Figure 15: DFW Forest Management Zones with Ecoregions.

elements of natural disturbance patterns into managed forestlands by extending conventional rotation lengths, increasing stand size, retaining clusters of mature trees, and fostering heterogeneity of tree species, tree quality, and tree size classes. Biological monitoring activities are conducted before and after the implementation of management activities at selected sites. This information can be used to modify future prescriptions.

Biological Monitoring

Monitoring is a key element of wildlife habitat management (Gray et al. 1996) and of an ecosystem approach to sustainable forestry (Bordelon et al. 2000). Monitoring data should allow the MDFW to determine if biodiversity conservation goals and landscape composition goals are being met. Monitoring occurs at both the spatial level, through GIS mapping of forest cover types and successional stages, and at the field level through sampling of forest songbirds, vernal pools, and vegetation. GIS mapping provides information on percentages of early, mid, and late-seral forest habitat within a given management unit, and also provides information on the diversity and abundance of forest types. Sampling of forest songbirds, amphibian and invertebrate wildlife in vernal pools, and forest trees, shrubs, and herbs determines whether or not complete assemblages of native species are present.

Breeding bird occurrence and abundance is used as an indicator of wildlife diversity because songbirds respond relatively quickly to changes in forest composition, and because various bird species that exhibit long-term population declines are of major conservation interest in the Northeast. Of special concern are less mobile groups that may re-colonize developing habitats more slowly than birds (Welsh and Healy 1993). Monitoring species composition and condition of tree, shrub, and herbaceous vegetation (Peet et al. 1998), as well as invertebrate and vertebrate occurrence in vernal pools (Kenney and Burne 2000) can help determine if biodiversity conservation goals are being met for less mobile species. Management goals are met when all forest types are represented in all seral stages, and when all forest types support complete assemblages of native plants and animals. Results of monitoring efforts should be evaluated against the stated objective to maintain biodiversity. Management practices that reduce biodiversity at the landscape level should be amended or discontinued.

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Conservation of Early-Successional Habitats in Massachusetts

The MDFW Upland Habitat Management Program (Upland Program) was developed to address long-term population declines in native wildlife species associated with non-forested, early-successional habitats. These open habitats have declined throughout the state over the past several decades, and the Upland Program seeks to stem this decline primarily through management of post-agricultural or abandoned field sites.

Abandoned field reclamation involves removing invading woody vegetation and controlling invasive exotic plants to re-establish early-successional habitat (i.e., native herb/shrub or grassland communities). The majority of native bird species associated with grassland and/or shrubland habitats are exhibiting regional long-term population declines (Figure 16).

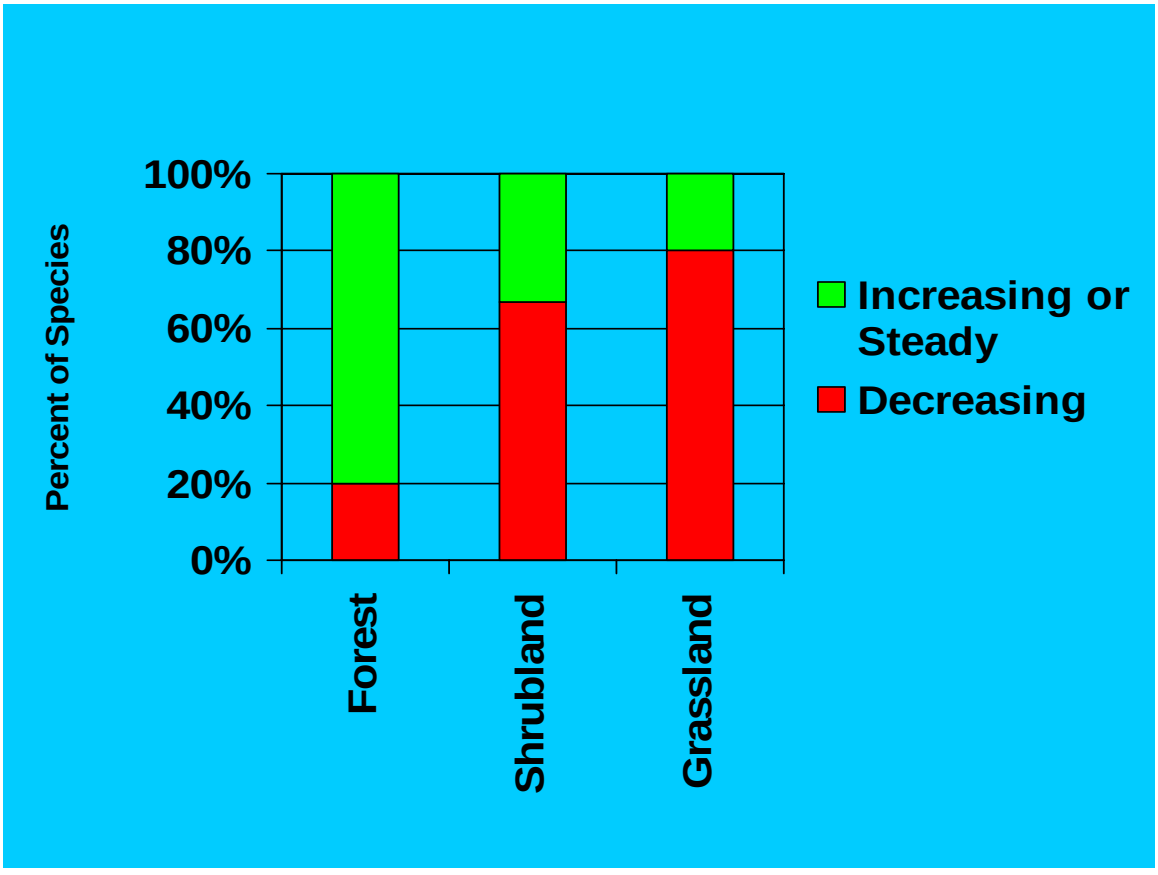

Figure 16: Bird population trends in Southern New England, 1966-2002.

Today it is necessary to create early-successional habitats through active management, due to historical human impacts on the landscape which have substantially curtailed certain natural disturbance processes that formerly replenished extensive areas of open habitats used by a wide variety of wildlife species. While disturbance by wind and pathogens still occurs periodically across the landscape, other disturbance agents have been curtailed by humans, primarily including relatively frequent ground fires within the extensive oak-hickory forest region of southern New England (which covers about 60% of Massachusetts, from the Connecticut River valley eastward to the Cape and islands), spring flooding along riverways throughout the Commonwealth, and beaver flowages along low-gradient streams in what are today densely populated areas of human development.

Spring ground fires, often set by Native Americans, produced shrub and grassland habitats beneath open oak forests. Spring flooding along riverways formerly maintained locally expansive wet meadows that were commonly exploited for hay by early European settlers. The construction of some 3,000 dams along Massachusetts rivers and streams essentially eliminated all of these wet meadow habitats. Following the loss of effective trapping methods to control beaver populations some 10 years ago, even relatively small beaver impoundments can soon cause substantial problems for home owners, businesses, and highway departments in Massachusetts today. Prior to European settlement, the low-lying lands that today support dense human populations formerly supported sprawling mosaics of herb/shrub habitats as flowages cycled in and out of active use by beaver. Taken together, all of these vibrant, open habitats must either be replaced through active management, or the wildlife species that are adapted to post-disturbance environments will continue to decline.

The Management Process

The priority of an individual property for management is determined by its landscape setting. High priority sites are relatively large (generally >2 ha), and/or occur adjacent to, or near (<400 m from) other open habitats. The Upland Program seeks to cluster larger areas of early-successional habitat as opposed to dispersing smaller areas of these habitats. This approach helps to maintain extensive, un-fragmented forestlands and to minimize any deleterious impacts of edge habitats on the landscape.

Active management of abandoned field areas often involves the use of industrial landclearing machinery to cut and mulch invading woody vegetation. Landclearing machinery includes industrial flail mowers (hydro-ax or an excavator-mounted rotary drum mower/mulcher) on sites that have been abandoned (unmanaged) for 10-15 years. For trees that are beyond the size capacity of flail mowers, tree shears, skidders, and chippers are used; typically on sites 15-30 years post-abandonment. Most, but not all woody vegetation is removed; valuable food-producing trees and shrubs such as wild apple, dogwood, viburnum, blueberry and serviceberry are retained.

Reclamation of abandoned fields also involves the control of invasive exotic vegetation that degrades natural communities. Invasive plant control is accomplished through mechanical and chemical methods, depending on the abundance of invasive plants. Small infestations of invasive plants are usually treated mechanically by pulling individual plants and their entire root systems

from the ground; larger infestations are typically herbicide-treated to kill the root system and prevent re-sprouting.

Invasive exotics often colonize disturbed sites where their faster growing rates, efficient dispersal mechanisms, and tolerance for a wide range of environmental conditions allow them to out-compete native species. As the populations and the distribution of invasive exotics increase, the diversity and populations of natives decrease, as does the diversity of habitats available for wildlife. In fact, invasive exotics have been implicated in contributing to the decline of 42% of those species listed as threatened or endangered by the U.S. Fish and Wildlife Service.

Invasive exotic vegetation found on upland sites includes Japanese and common barberry, multiflora rose, glossy and common buckthorn, Asiatic bittersweet, autumn olive, and others. When herbicide control is required, a selective foliar spray or cut-stem application is used. Reclamation sites are not broadcast treated; only individual invasive exotic plants are treated. Herbicides are applied only by experienced applicators that are licensed by the Massachusetts Department of Agricultural Resources (DAR). Herbicides are limited to those recommended for use in sensitive areas on right-of-ways by DAR. Sensitive areas include sites within 400 feet of a public ground water supply well, within 100 feet of a public surface water supply, within 50 feet of private water supplies, within 10 feet of surface waters and wetlands, and within agricultural and inhabited areas.

Partnerships

Upland Program reclamation sites are not restricted to MDFW-owned properties, but rather are located on high-priority public and private properties across the state. The Upland Program has partnered with town governments, private land trusts, private landowners, and other state agencies to accomplish high priority reclamation projects. The Upland Program has also partnered with the Federal Natural Resource Conservation Service through their Wildlife Habitat Incentive Program to attract sufficient funding for high priority projects.

To date, the Upland Program has reclaimed over 700 acres of early-successional habitat at 31 different sites across the state, and has worked to control invasive exotic plants on more than 500 acres at 12 reclamation sites across the state. Through the various partnerships described above, these management efforts have included a variety of public and private lands.

The Upland Program has also established a long-term partnership with The Massachusetts Coverts Program, which organizes and administers an annual three-day educational workshop for private landowners and public land managers on the best land management practices for enhancing wildlife habitat. Through this partnership, the Coverts Program has trained over 100 individuals, including private forestland owners, non-profit land trust administrators, town conservation commissioners, municipal conservation leaders, state representatives and their assistants. In all, these participants are responsible for the stewardship and management of nearly 100,000 acres throughout Massachusetts.

Biological Monitoring

Monitoring and research are required to assess current management priorities, strategies, and accomplishments. A long-term monitoring program of birds, butterflies, and vegetation

documents changes that result from reclamation activities on nearly 1000 acres at 15 different Upland Program sites. Monitoring is conducted prior to initial reclamation treatments, and then at intervals (usually two years) after the treatments. Monitoring results will be crucial to assessing the effectiveness of the program in conserving wildlife species associated with early-successional habitats. Management strategies will be adapted as necessary depending on the outcome of monitoring.

The Upland Program funds biological research when the results can be directly used to assess management priorities and strategies. Dr. John Litvaitis, University of New Hampshire Natural Resources Dept., led a survey of the New England cottontail, a species associated with early-successional habitats. New England cottontail populations have declined by 80% over the last 40 years. The survey provided information on current New England cottontail range and habitat use in Massachusetts. The Upland Program is currently funding a study led by Dr. David King, U.S. Forest Service Northeastern Research Station, to determine nesting success of birds species of conservation concern on Upland Program reclamation sites. Results will indicate whether reclaimed habitat patches serve as "source" habitat or "sink" habitat for declining bird populations (source habitat provides adequate resources for species to successfully reproduce and thus maintain viable population levels, while sink habitat attracts breeding adults, but does not provide adequate resources for successful reproduction – often due the presence of edge predators that destroy nests and/or prey on juvenile animals).

3. Fisheries Section

Structure and Functions

The Commonwealth's aquatic resource inventory includes a variety of fisheries habitat types ranging from coldwater wild trout streams, to Atlantic salmon and shad rivers, to warmwater lakes and ponds abundant with panfish species. There are approximately 1,300 lakes and ponds encompassing more than 120,000 acres, and over 2,000 streams and rivers totaling more than 11,000 miles in length.

The importance of these aquatic habitats and the fisheries resources they support are important not only ecologically, but also recreationally and economically. More than 615,000 people (aged 16 and older) spend more than 7,685,000 days fishing in Massachusetts each year, and more than 225,000 kids under the age of 16 enjoy freshwater fishing across the state each year. Fishing pressure in Massachusetts is estimated at 40 trips/acre versus the national average of 27 trips/acre.

Economically, freshwater fishing is big business in Massachusetts and makes up a significant part of the state's economy. The average angler fishes 14 days a year and spends $632. Retail sales for recreational fishing in Massachusetts top $494,165,471 each year, creating some 8,169 jobs across the state. Those jobs, in turn, generate earnings (wages and salaries) of more than $225,328,262 resulting in over $10,600,000 in state income taxes and $38,887,196 in federal taxes. Total economic output is nearly $1 billion annually.

The protection, management and enhancement of the Commonwealth's inland fisheries resources and their habitats involve several important and ongoing fisheries projects. These projects include the restoration of Atlantic salmon and shad in the Connecticut and Merrimack Rivers, the fisheries conservation and habitat initiative, stream survey and inventory of fisheries resources and critical habitats, warm and coolwater fisheries management, large reservoir fisheries management (Quabbin and Wachusett reservoirs), fish culture and production (including the annual production of more than 400,000 lbs. of trout and 2 million salmon fry), fish kill investigations, environmental review and assessment, and the sport fish awards program. In addition, fisheries personnel represent the agency on several important committees and commissions that directly affect fisheries conservation in the Commonwealth including the state Water Resources Commission, Connecticut River Atlantic Salmon Commission, the Merrimack River Anadromous Fish Restoration Policy Committee, Inter-Agency Committee on Toxics-in-Fish, Fish-Kill Coordination Committee, Stressed Basins and Stream Flow Policy Committees.

Recent Projects

Biodiversity and Fisheries
These ongoing fisheries projects are critical relative to protecting, maintaining, restoring and enhancing the state's biodiversity relative to fisheries. In particular, the fisheries conservation and habitat initiative, anadromous fish restoration project and environmental review and assessment play crucial roles in addressing the fish species in greatest need of conservation.

Fisheries Conservation and Habitat Initiative
The Fisheries Habitat Conservation and Restoration Initiative helps to protect and maintain the biodiversity of the Commonwealth through a variety of programmatic processes. The key is a focus on habitats and communities, rather than on individual sites and species. The initiative was conceived as a way to illustrate the current condition of the resource and describe restoration priorities. Although products from the Initiative include benefits for our traditional recreational constituents, a higher standard was envisioned to benefit all fisheries resources under our mandate.

The MDFW is responsible for the conservation, restoration, and management of fish and wildlife resources. This project analytically assesses aquatic resources in the Commonwealth, identifies those resources that are in the most need of restoration and conservation, and ultimately protects the biological integrity of fish and wildlife habitat at the watershed level. Fish and fish communities serve as excellent indicators of environmental condition for several reasons. Fish are sensitive to a wide array of stresses, integrate the impacts of those stresses in their attempts to survive, reproduce, and grow, and are relatively long lived (Faush et al. 1990). The MDFW will use fish community assessments to identify the current status of fish and wildlife resources, implement Target Fish Community (TFC) analyses to set measurable goals for restoration, and rely on habitat mapping and Indexes of Biotic Integrity (IBIs) to set the most efficient course for accomplishing those goals.

The challenges facing contemporary aquatic resource management involve complex interactions of biotic and abiotic factors that occur at multiple scales. Biological criteria must be the focus of assessment protocols. Chemical and physical criteria are poor substitutes for biological criteria,

yet currently dominate resource assessment protocols. While this has been especially true of the U.S. Clean Water Act (CWA), it also typifies other water resource management policies and regulations. This is frequently due to the emphasis by management and regulatory agencies on these more easily measured and managed surrogates (National Research Council 2001), which partly results from the constant demand for quick, if imperfect, results (Yoder and Kulik, 2003).

Fish Community Assessment: Identifying the Current Status.
Fish communities will be assessed and used as a measure of the biological integrity of fish and wildlife habitat.

Fish population surveys have been conducted in Massachusetts in many forms since the 1940s (Hartel et al. 2002). Many of these surveys were excellent but narrow in scope, typically focusing on just a few recreationally important species. Smaller streams were sampled more often than larger rivers because of equipment limitations. Efforts in the past few decades were comprehensive in their habitat and fish community directives, but were not watershed-oriented. This made watershed-wide fisheries assessments difficult to complete.

The formal process of MDFW watershed assessment began in 1998 with the survey of the mainstem of the Ipswich River and subsequent tributary sampling in 1999. Watershed assessments have now been initiated in 23 of the 26 major watersheds in the Commonwealth. Stream survey protocols have been formally applied to sample representative habitats in each watershed and accurately describe their fish communities. The protocols focus not only on collecting recreationally important fish species, but also the relative abundance of all fish species in the existing community.

Stream survey and inventory benefits traditional constituents directly by providing information on where game species do and do not exist, in what sizes, and in what abundances. Stream survey and inventory helps to protect biodiversity in general by providing information on all species and documenting locations of listed fish species. Locations with overall low fish abundance or a dominance of a single or few species are also initial indicators of habitat quality and will help to focus attention in areas with habitat degradation. In addition to the research on the sampling locations, a considerable amount of time is spent during the survey examining habitats relative to their quality and potential for degradation. GIS overlays and in depth topographic maps are extremely useful tools, but are still no substitute for field investigations.

Watershed-based fish community assessments will allow us to focus restoration and conservation on watershed, reach, and site-specific habitat scales. The data and process will form the foundation for restoration and conservation efforts statewide, including the establishment of Target Fish Communities, fish habitat mapping (MesoHABSIM), Indexes of Biotic Integrity, identification of high quality warmwater and coldwater fishery resources, and other resource management processes. For this purpose, a coldwater fishery resource is defined as follows:

1. The presence of a reproducing salmonid population; or
2. The presence of one of the following non-salmonid coldwater fish species:
   - Slimy Sculpin (*Cottus cognatus)*
   - Longnose Sucker (*Catostomus catostomus)*; or

3. The presence of Atlantic salmon (with the exception of the Connecticut and Merrimack River mainstems and waters stocked by MA DFW with broodstock Atlantic salmon); or
4. Listing as a water stocked with Atlantic salmon as coordinated by the Atlantic Salmon Restoration Effort; or
5. Regional biologist's input indicating a year-round trout fishery that is managed as a coldwater fishery resource; or
6. Water currently designated as Coldwater in the Massachusetts Water Quality Survey.

Target Fish Community Analyses: Setting Measurable Goals for Restoration.
Target Fish Community (TFC) Assessments will be used to prioritize watersheds in greatest need of restoration, and also to set baselines for conservation.

The TFC methodology was developed to describe a fish community that is appropriate for a natural river when streamflow and biological integrity are maintained. The TFC is used as a benchmark for comparison to existing fish communities in potentially degraded watersheds. The TFC addresses biological issues. Habitat, water quality, and water quantity degradation will result in shifts in fish community structure that can be monitored in the TFC process. Likewise, improvements in these parameters will result in positive shifts in the fish community structure that can also be measured.

The TFC concept was developed at Cornell University by Bain and Meixler (2000) in cooperation with state and federal fishery and natural resource professionals. Key agencies represented include Massachusetts Division of Fisheries and Wildlife, Massachusetts and Connecticut DEP, U.S. Fish and Wildlife Service, U.S. Geological Survey and EPA. The approach was designed during a research project on the Quinebaug River in Sturbridge and Southbridge, MA to provide a measurable goal for river restoration. The TFC process has also been applied to the Ipswich River, in conjunction with research conducted by USGS, to document the severely impaired condition of that resource (Armstrong et al. 2001).

Defining a TFC involves assembling fish collections from several rivers that are identified by management agencies as being in a desirable fishery state. These resources are then referred to as "quality rivers." The use of quality rivers as a surrogate for a more traditional "reference" river is a realistic methodology for New England waters, as true reference conditions rarely, if ever, exist in moderate to large rivers. These data are compiled and summarized to identify the 10 most common fish species that would be expected in a healthy or restored ecosystem. These 10 species then make up the majority of the fish species in the TFC. Fish species are then classified into macrohabitat classes: macrohabitat generalists (also referred to as pond fish species), fluvial dependents, and fluvial specialists (also referred to as river fish species) based on habitat requirements.

The fish species proportions in the TFC are then compared to species proportions from recent fish surveys conducted during the fish community assessment phase of the process. The comparisons of target and current fish communities will then be made using a percent model affinity procedure (Novak and Bode 1992).

The TFC methodology employs a readily understandable common-sense approach to fish community assessment and resource monitoring and provides a measurable goal for restoration. The TFC can be used to evaluate the benefit of resource enhancement or protection methodologies, like instream flow and habitat improvement, once they have occurred.

Fish communities, sampled through standardized methodologies in free-flowing reaches of moderate-sized rivers, should consist primarily of fish species adapted to live in lotic conditions. Rather than relying on a single-species approach to resource protection (i.e. eagles or salmon), which tends to accentuate the value of relatively few charismatic or commercially important species, the TFC highlights fish community characteristics that are easy to understand and interpret, and much more indicative of ecosystem integrity.

The TFC is an excellent tool for developing a measurable goal for fish community restoration and conservation, and should be used to prioritize restoration efforts in each watershed. The Ipswich River is in need of considerable restoration. Severe water withdrawal from the Ipswich watershed has created a fish community that is dominated by macrohabitat generalist (pond) fish species.

Watersheds can differ in many ways (e.g. elevation, geology, gradient). More than one TFC will be developed to account for these differences and to describe the restored fish communities in Massachusetts. The TFC approach has a sound ecological foundation that has been successfully applied in the Quinebaug, Ipswich, and Housatonic River watersheds. TFC work in the Charles and Taunton Rivers is underway or proposed. Considerable work still needs to be done, however, to incorporate this methodology into a statewide concept.

The results of the TFC process lead to a restoration (if resources are impaired) or conservation (if resources appear stable) decision. Monitoring plans keep the focus on watershed management, with the mainstem study reach measuring watershed health. Other methodologies will be used to provide monitoring and protection at more local levels.

Development of Indexes of Biotic Integrity.
The results of fish community assessments will also provide valuable information that will lead to the development of Indexes of Biotic Integrity (IBI) for stream and river resources within the state. IBI's were originally developed to evaluate warmwater streams in the midweastern US (Karr 1981) and have become popular in many other regions (Langdon, 2001). An IBI is a multimetric index (originally 12 metrics) that incorporates individual and community level attributes for stream fishes. Typically, species richness, composition, trophic and reproductive characteristics, fish health and density parameters are incorporated into an IBI (Karr et al. 1987). Regional differences in fish fauna need to be examined to determine if more than a single IBI needs to be developed (Smoger and Angermeier, 2001), even in a small state such as Massachusetts.

Once developed, the IBI metrics and indices provide meaningful measures of assemblage quality and response to chemical, physical, and biological influences and perturbations. This has been demonstrated for a wide variety of human impacts including water pollution, habitat and flow alterations, and land use changes. It has only been during the past two decades that practical and

ecologically robust biological assessment methodologies and criteria have become available. Key among these advances is the IBI, which introduced the concept of multimetric assessment indices to the assessment of aquatic species assemblages. While much of the ensuing use of the IBI in North America has supported water quality applications, it offers a largely unrealized potential to contribute to other water resource management issues using the same approach (Yoder and Kulik 2003).

Key in the development of an IBI for Massachusetts will be the inclusion of more flow-sensitive metrics that are based on the Target Fish Community (TFC) concept. Collaboration with federal, state, and university entities will provide regional focus to the application of biologically-based multimetric indicies in the Commonwealth.

Habitat Mapping: Setting a Course for Restoration.
Habitat mapping will be used to establish the most efficient means of achieving physical habitat or flow restoration in each watershed. Fish habitat mapping (MesoHABSIM) will guide restoration efforts in mainstem study reaches toward restoring the TFC.

Once fish community assessment has been conducted to determine the current status of each watershed and TFC analyses have been conducted to prioritize the resources in greatest need of restoration and conservation, habitat mapping will be used to develop the most efficient course for restoration and the alternatives at our disposal.

MesoHABSIM (Parasiewicz, 2001) uses widely accepted concepts of habitat and ecology and focuses on the mesohabitat scale. Mesohabitat refers to important biological types of river habitat (e.g. riffles, runs, and pools) and the association of certain fish species with specific mesohabitat types. MesoHABSIM describes the quantity of the habitat available in a river, or portion thereof, at various flows. The results can be used to focus on improving the habitat for fluvial fish species in the TFC.

MesoHABSIM allows large river reaches to be fully assessed and can be used in concert with a GIS analysis. In addition to instream flow applications, this method can also be used to predict habitat and fish community responses to other river restoration projects such as dam removal or channel alterations.

The purpose of MesoHABSIM is to develop a baseline habitat description, compare available habitats for the fish species in the TFC, and determine the best way to increase suitable habitat for those species under varying flows. Those habitat improvement methods (dam removal, stream-bank restoration, etc.) that would most efficiently increase the appropriate habitat can be outlined and monitored to produce the best results.

MesoHABSIM will further set priorities for restoration, the success of which will be monitored and measured through the TFC process. Improvements in habitat will translate, through time, into improvements in the fluvial fish community.

Five-Year Action Plan

Fish Community Assessment
The goals for the fish community assessment portion of the project will be to continue to sample 180 to 220 locations each year. The sampling locations will follow the watershed rotation that has been employed since 1999. Priority will be given to sites that will ensure the adequate establishment of the condition of the fish community in mainstem study reaches to enable the comparison of existing conditions to TFCs as they are established. Priority will also be given to potential Coldwater Fishery Resource waters to allow biological assessments and set management goals for wild salmonids statewide. Index sites will also be selected and resurveyed to monitor trends in fish populations across the state.

Target Fish Communities
TFCs will be established, either individually, or through a regional approach, for mainstem study reaches in the Hoosic, Westfield, Farmington, Connecticut, Deerfield, Millers, Chicopee, Ware, Quaboag, Swift, Nashua, French, Blackstone, Concord, Sudbury, Assabet, Merrimack, Shawsheen, Ipswich, Parker, Charles, and Taunton Rivers. Mainstem study reaches will include a proportion of the entire mainstem reach that will be determined by watershed area and habitat complexity.

Mesohabitat Mapping
Mapping has been conducted in the Quinebaug River in Southbridge and Sturbridge, MA. Similar mapping will occur in the remaining watersheds following methods prescribed by Parasiewicz (2002). Mesohabitat mapping will also be conducted on larger (> 30 square mile) tributaries to the rivers listed above and on rivers in the smaller watersheds that meet the criteria (Islands, Cape Cod, North Coastal, South Coastal, Narragansett, Ten Mile, Mount Hope Bay, and Boston Harbor Watersheds). The goal will be to map all or representative portions of all watersheds greater than 30 square miles.

Indexes of Biotic Integrity
Although IBIs will be applied to all streams sampled, those in watersheds of 30 square miles or less will be the focus of the effort. Methodologies for developing IBIs will follow Karr (1981).

Reference sites with exemplary fish communities will be selected statewide. Data will be gathered to determine if different (or more likely how many different) IBIs need to be constructed for regional or biological applications in the Commonwealth (e.g. Coastal, Berkshire coldwater and warm water resources). Although much of the data has been gathered to begin calibrating these IBIs, more will be gathered that will fill in the remaining gaps in the database. All streams in the database will have IBI data generated and fit within a watershed framework to determine high priority locations for further assessment, restoration or protection.

Anadromous Fish Restoration Project
The anadromous fish restoration project strongly supports the biodiversity in the Commonwealth by restoring extirpated anadromous fish species to their historic habitat and range, and by enhancing existing diadromous fish populations in the Commonwealth.

When the first European settlers arrived in the Connecticut and Merrimack River valleys, Atlantic salmon were found throughout both basins. However, native salmon populations soon began to disappear after the construction of impassable dams blocked access to critical spawning habitat on the main stems and tributaries of these river systems. This, coupled with pollution and over harvest, brought about the complete demise of this important and valuable native species.

The MDFW has been activity involved in restoring anadromous fish to both the Merrimack and Connecticut river basins for more than three decades. The restoration program for Atlantic salmon became a reality when the federal Anandromous Fisheries Conservation Act (1966) made funds available for interstate fish restoration programs. Additionally, water pollution control programs as a result of the passage of the Clean Water Act (1967) markedly improved water quality in river habitats. In the Connecticut River, formal Atlantic salmon restoration efforts also commenced in 1967 when the Connecticut River basin states, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service signed a statement of intent to restore anadromous fish to the Connecticut River. In 1983, Congress formalized the state and federal agreements and passed the Connecticut River Basin Atlantic Salmon Compact which created the Connecticut River Atlantic Salmon Commission (CRASC).

Formal anadromous fish restoration efforts in the Merrimack River basin commenced in 1969 when the states of Massachusetts and New Hampshire along with the U.S. Fish and Wildlife Service and National Marine Fisheries Service agreed to support an anadromous fish restoration program for the Merrimack River basin. Comprehensive strategic plans were developed to guide anadromous fish restoration efforts in both basins, as well as for two important tributaries, the Westfield and Deerfield Rivers. Both these tributary basins contain vast amounts of spawning and nursery habitat for Atlantic salmon as well as other anadromous fish species.

Fry Stocking

An important part of the anadromous fish restoration program is the stocking of Atlantic salmon fry. The Division stocks more than 2 million fry each year in the Connecticut Valley. The Roger Reed Hatchery, located in Palmer, MA, is a three person station dedicated solely to producing salmon fry for the restoration program. The station maintains broodstock salmon that are spawned each fall for the production of fry. In the spring, these salmon fry are stocked into streams identified in the habitat surveys conducted by the MDFW as part of the project. The task of stocking more than 2 million salmon fry could not be accomplished without the annual assistance of more than 100 committed volunteers. These volunteers are vested in the program and provide hundreds of hours of in-kind services to the restoration program.

Habitat Survey and Inventory

As part of the anadromous fish restoration project the MDFW has surveyed and mapped miles of important salmon and coldwater fisheries habitat in the Connecticut Valley. This important habitat information is in a GIS data layer and available to anyone, including town conservation commissions, nonprofits, watershed associations and conservation organizations. The MDFW surveyed virtually every stream in the Westfield and Deerfield basins and numerous others in the Chicopee and Millers River basins. The survey includes physical descriptions of the habitat along with water quality measurements. Sampling on each stream included identification and enumeration of all fish species. Representative fish samples were weighed and measured for total

length. Scale samples were also collected for age and growth analysis. These data were used to evaluate fry stocking sites by estimating salmon smolt production each summer. Based on these production estimates, fry stocking densities could be adjusted to reflect the quality of the habitat. These surveys also provided invaluable documentation on resident fish species, including abundance and distribution.

Impacts of Dams of Habitat of Diadromous and Resident Fish Species

The negative impacts of dams on the natural diversity of aquatic habitat in this state cannot be overstated. With more than 3,000 dams, (see Figure 4) the result has been a profound alteration of the natural aquatic habitat and biodiversity in this state. First and foremost, dams fragment habitat and disrupt natural stream ecosystems. Dams do this by creating physical barriers to natural movements of resident and diadromous fishes, including access to spawning, nursery, feeding, and refuge habitat. Dams also physically change aquatic habitats both upstream and downstream of the barrier. Upstream of dams, once flowing waters are now impounded and create entirely new ecosystems that now favor pond species to the detriment of native stream fishes. Accumulation of sediments destroy important spawning habitat for riverine fishes and alter water quality, including dissolved oxygen and temperature.

Dams that divert water create "bypass reaches" that may be completely devoid of water, eliminating most, if not all aquatic habitat. Dams that store and release water can alter the natural hydrography both daily and seasonally, thereby creating unfavorable habitat conditions for fluvial fish species and negatively impacting fisheries biodiversity.

Miles of riverine habitat have been altered as a result of these dams, and consequently impact numerous native fish species in great need of conservation.

Species in Greatest Need of Conservation

Diadromous fish species, those which must migrate between freshwater and the sea to complete their life histories, have been very seriously affected by dams in MA. Populations of Atlantic salmon in the Commonwealth were driven to extinction during the 19th century, and many local populations of American shad, Blueback herring, Alewife, Sea lamprey and American eel were either extripated or reduced to remnant status due in part to habitat fragmentation caused by extensive dam construction from the time of colonization through the industrial revolution.

Habitat fragmentation and alteration have also affected a number resident fish species that find the now impounded river habitat unsuitable. These species include fallfish, common shiner, white sucker, longnose dace, blacknose dace, creek chub, creek chubsucker, slimy sculpin, brook trout, brook lamprey, and tessellated darter.

Environmental Review and Assessment

The environmental review and assessment project protects biodiversity by identifying and protecting critical habitats of species in greatest need of conservation, as well as other fish species. The basis for our environmental review and assessment work is a strong scientific fisheries database. The MDFW is engaged in a number of environmental review activities that directly protect biodiversity in the Commonwealth, including permit reviews such as groundwater withdrawals, interbasin transfers of water, 401 permits, and NPDES permits. In

addition, we review construction and development projects, lake management projects, and we are the lead agency for fish kill investigations in the Commonwealth. We also protect biodiversity by representing the agency on a number of important committees that affect fisheries and wildlife habitat in this state, including the Water Resources Commission, the Stressed Basin Committee and Stream Flow Committee. These committees represent a significant commitment by fisheries staff in terms of both time and energy, but have real implications for protecting the state's biodiversity. For example, the State Water Resources Commission sets water conservation standards and approves or denies applications for interbasin transfers of water. The Stressed Basin Committee is identifying the basins in greatest need of water conservation, while the Stream Flow Committee is working to formulate a statewide streamflow policy for the Commonwealth.

Construction and Development

The fisheries section reviews over 100 projects each year that have the potential to negatively impact fisheries habitat and biodiversity. These projects include road and highway construction, bridge rehabilitation and replacement, pipeline crossings in streams, thermal discharges from co-generation plants, storm water runoff from parking lots and other impervious surfaces, housing developments adjacent to streams, and culvert replacements. All of the projects which the MDFW reviews result in the issuance of various permits. These include 401 Water Quality certificates, NPDES discharge permits, wetlands permits, etc. Our review process assures that the proposed work, discharge, management, etc., will be done in such a way as to minimize impacts to our fish species in need of greatest conservation.

The types of projects mentioned above can negatively affect and alter aquatic habitat for our fish species in greatest need of conservation; directly during the construction phase, and indirectly during their long-term use. For example, during the construction of a new residential development, unchecked runoff of sediments can make their way into nearby streams. The sediments are then transported downstream, impacting spawning habitat and subsequent fish production. The long-term use of the newly constructed development can also impact the same streams. If storm water runoff from the impervious surfaces makes its way into the same streams, it may increase water temperature, negatively impacting abundance and distribution of sensitive coldwater fish species. This is also the case during the operation of co-generation plants, which have the potential to increase the temperature of receiving waters through their thermal discharge.

As with new developments, road construction, bridge and culvert replacements and pipeline stream crossings can have impacts during both construction and operation. If best management practices for erosion and sedimentation control are not strictly adhered to during construction, streams can be negatively impacted through sedimentation, releases of petrochemicals and construction debris, destabilization of stream banks, and other changes in riparian habitat. Conversely, if the projects are not designed properly in the first place, new bridges and culvert replacements can act as an impediment to fish movement within the streams, while pipelines buried in the streambed can alter the stream gradient.

All of our fish species in greatest need of conservation will ultimately be impacted if the quality of a water body is compromised; however, several have *high* potential to be negatively affected

by various projects through impacts on their habitats. These include swamp darters which require clean, cold, well oxygenated waters for their populations to thrive; alewife and American eel which, during their spawning migrations, require unimpeded passage to and from their spawning grounds; and white suckers which require clean, flowing riffles for optimal spawning habitat.

Lake Management Projects

Accelerated eutrophication and the spread of invasive aquatic plants in lakes and ponds across the Commonwealth are a growing problem that not only affects recreation and aesthetics, but also habitat for lake fisheries communities. This accelerated eutrophication and spread of invasive plants is negatively impacting fish habitat, and subsequently, species abundance and diversity. Fish habitat can be affected in a number of ways. Accelerated eutrophication can change the chemical composition of a water body, decrease depth through sedimentation, and decrease the available habitat for coldwater dependent fish species. When invasive plants spread throughout a lake, they can literally choke fish out of entire areas by replacing a multitude of species with dense monocultures. Dense stands of aquatic vegetation can also negatively impact important water quality parameters, particularly dissolved oxygen at critical times of the year. This accelerated eutrophication and spread of invasive plants has created a situation where most lakes and ponds in Massachusetts are in need of some form of management. However, the most commonly used lake management alternatives, including herbicide treatments, weed harvesting, drawdowns and dredging, can in turn impact lake fisheries habitat. These include impacts such as the loss of fish and spawn during mechanical harvesting or dredging, the temporary loss of habitat during a drawdown, or the loss, during herbicide treatments, of beneficial plants that fish species are dependent upon.

The fisheries section was actively involved with other state agencies in creating a final generic environmental impact report (GEIR) on eutrophication and aquatic plant management in Massachusetts. This GEIR discusses all the lake management methods currently approved for use in Massachusetts, the pros and cons of each method, and which method is most appropriate for each individual situation. This document has gone a long way toward making sure that proponents for lake management projects have reviewed all the potential issues involved and chosen the most appropriate technique. We review and provide technical input on numerous lake management projects each year to insure that these projects are designed and conducted in such as manner as to minimize impacts on fish habitat and benefit it through restoration wherever possible.

All of our fish species in greatest need of conservation will ultimately be negatively impacted if eutrophication and the spread of invasive aquatic species go unchecked. Likewise, they may be directly impacted by the very management that is needed to remedy the situation. For example, virtually all fish species require submerged aquatic vegetation during at least some phase of their life history, be it as spawning substrate, nursery habitat or predator avoidance. Specifically, bridle shiner, banded sunfish, and swamp darters are frequently found associated with submerged aquatic vegetation during all their life stages, and it is critical to the successful spawning of these species. Common shiners are also dependent on vegetation, as it has been shown to make up a small percentage of their diet. Some of our species in greatest need of conservation may also be indirectly impacted by lake management techniques such as drawdowns. Alewife and American eel require unobstructed access into lakes and ponds to complete their anadromous life cycle,

while white sucker and common shiner require access to flowing water outside of the lake for successful reproduction. The timing of drawdowns is therefore a critical factor for these fish species.

Fish Kill Investigations

In 1999, the Massachusetts Departments of Environmental Protection (DEP), Fisheries, Wildlife & Environmental Law Enforcement (DFWELE), Food and Agriculture (DFA), and the Massachusetts Division of Fisheries and Wildlife (MDFW), recognizing that fish kills are significant events that warrant the attention of their particular agencies, entered into a memorandum of understanding to coordinate and facilitate the investigations and prosecutions of fish kills. The sight (and smell) of up to hundreds of dead and dying fish along the shores of a water body can be a distressing site and immediately bring thoughts of pollution. Fish do act as the "canary in the coal mine," so it's natural that an eyewitness to such an event would naturally assume the fish kill was the result of pollution. As the lead agency in the reporting of all fish kills in inland waters, the MDFW has a biologist review each call, and through a series of questions, make a determination on whether the kill is natural or requires a site investigation. If, through this screening process, the MDFW determines the reason for the kill is other than natural causes, the DEP is notified immediately (or the DFA if the kill is suspected to be caused by a pesticide or herbicide application). The DEP (or the DFA), in turn, is responsible for the collection and laboratory analysis of water and fish samples, identifying the contaminants, determining the source and identifying the responsible parties. The MDFW is responsible for identifying, enumerating and establishing monetary value of the dead fish. The MDFW also maintains a 40+ year database which helps track waters with a history of fish kills. This 40+ year history of tracking fish kills has shown that the vast majority of fish kills reported turn out to be natural limnological events such as low dissolved oxygen. However, although these are natural events, accelerated eutrophication, long-term inputs such as road runoff or faulty septic systems, and the spread of invasive aquatic plant species can all increase the frequency of such events.

Natural fish kills are generally the result of low oxygen levels, spawning stress or fish diseases. Dissolved oxygen depletion is one of the most common causes of natural fish kills. As water temperature increases, it simply cannot hold as much oxygen as when it was cold. During the long hot days of summer, oxygen levels in shallow, weedy ponds can further decline as the plants consume the oxygen at night, resulting in low oxygen levels in the early hours of the morning. This situation can become critical if the levels fall below that required for fish to survive (approximately 4-5 parts per million). In addition to the depressed oxygen conditions, late spring and early summer are when most warmwater fish species such as sunfish (bluegill, pumpkinseed, largemouth bass, etc.) begin to spawn. Large numbers of these species crowd into shallow waters at this time, vying for the best spawning sites. These densely crowded areas are susceptible to disease outbreaks; especially as water temperatures increase. The result is a fish kill.

Conversely, thick ice and heavy snow cover can also create low dissolved oxygen levels. Increasing ice and snow packs limit light penetration through the water column, altering chemical and biological processes such as photosynthesis and the decomposition of organic matter. This can result in the release of strong "rotten egg" odors from some bodies of water. The odor is hydrogen sulfide gas, a natural by-product anaerobic bacterial action that is frequently

mistaken for pollution such as illegal dumping, sewage or a chemical spill. The resulting low dissolved oxygen conditions can frequently result in a winter fish kill. Ponds that are shallow and weedy are particularly vulnerable. Oxygen levels will be fully restored when the ice melts in the spring. At "ice-out," winter fish kills often become visible to the public for the first time in the form of dead fish on the bottom of the pond or floating at the surface.

Pollution related fish kills run the gamut from chronic inputs of pollutants to a water body, to one-time releases of toxic materials. Fish kills, be they natural or pollution related, have the potential to negatively impact all our fish species in need of greatest conservation. These impacts can have a direct effect by reducing biomass or eliminating whole year classes, or in the case of pollution events, making the habitat required by these species uninhabitable in the short or long term.

4. Other Agency Programs

Land Acquisition Program
As part of this agency's initiative to protect and perpetuate ecosystems that contain significant fish and wildlife resources and to conserve the biological diversity of the state, the Massachusetts Division of Fisheries and Wildlife (MDFW) conducts a program of habitat acquisition with the understanding that lands so acquired shall, wherever appropriate, be open for compatible public use and enjoyment. Under this policy, the agency seeks to acquire both the most ecologically valuable habitats and natural communities, and to provide premium opportunities for passive recreation, including hunting and fishing.

Parcels for protection are identified through a statewide planning process and recommended for acquisition in a given fiscal year by a Lands Committee, comprised of staff of both the Department of Fish and Game and the MDFW. The program works closely with the MDFW's Chief of Wildlife Lands, Land Agents, Natural Heritage and Endangered Species Program staff, and habitat management scientists. The process through which this takes place is detailed in Appendix D.

The Lands Committee meets regularly to examine focus areas, and twice annually to review proposed acquisitions. Parcels are then ranked based upon factors such as habitat value, proximity to other protected lands, recreational opportunities, manageability, and price.

Funding for habitat acquisition comes from bond funds authorized to the Commissioner and/or the Department, and from income obtained through sale of the state's Wildlands Stamp. This stamp, which costs $5, is a required purchase for everyone who buys a fishing, hunting, trapping, or sporting license in the Commonwealth.

Currently, the Department owns and manages (through the MDFW) one hundred and thirty thousand (130,000) acres of land in Wildlife Management Areas across the state.

Landowner Incentive Program
Over 80% of the land base in the Commonwealth is in private ownership, hence privately owned lands are of vital importance in providing fish and wildlife habitat in Massachusetts. Given this

situation, wildlife conservation goals cannot be fully achieved by focusing effort solely on public lands. Most of the designated rare wildlife species in Massachusetts, along with other species of plants, animals and habitat types that are in serious decline, are found on privately owned lands. The survival of these species and their habitats, as well as the continued health of more common species and habitat types, depends largely on how privately owned lands are used and managed. Restoring and maintaining habitat on these lands is essential; the only way we can protect the complete diversity of native wildlife resources is through partnerships with willing landowners.

The MDFW Landowner Incentive Program (LIP) builds partnerships that provide such private landowners interested in developing and maintaining wildlife habitat on their properties with financial and technical assistance. State biologists are currently working with private landowners to enhance and protect important habitats across the Commonwealth.

To promote the creation/restoration of high quality habitat that supports wildlife populations, funding has been dedicated for on-the-ground activities that enhance wildlife habitat and provide benefits for species at-risk. The State has adopted a competitive, cost-share grant program to assist landowners to meet that goal.

The goals of this program are to:

- Identify and reclaim appropriate sites for management of declining habitats
- Manage and control exotic and invasive plants
- Enhance wildlife habitat for species at risk
  (A "species at risk" is defined for LIP as any fish or wildlife species that is federally or state listed as threatened or endangered, is a candidate for listing as threatened or endangered, or is listed on the NHESP Official State Rare Species List.)
- Provide technical and financial assistance and guidance to landowners on how to manage their properties for wildlife

Partnerships are initiated through annual LIP workshops that promote sound management of private lands and educate landowners about the ways they can help maintain the natural biodiversity of Massachusetts through wildlife stewardship. These partnerships are reinforced with technical advice and concurrent site visits, and are established with long-term conservation goals in mind.

A more detailed view of the operations of the Landowner Incentive program is contained in Appendix E.

Information and Education

The Information and Education (I&E) Section has the responsibility and challenge of keeping the public — particularly sportsmen, conservationists and other wildlife constituents — apprised of regulations, laws and recreational opportunities related to wildlife. It provides news about wildlife and maintains a flow of information about wildlife related issues. In order to enhance public understanding of wildlife management and compliance with laws and regulations involving wildlife, the I&E Section maintains an active program of educational outreach to develop a public which is aware of, and in tune with, wildlife issues. The Section also focuses on increasing public awareness, appreciation and understanding of our wildlife resources through

programs conducted in both formal educational settings (schools) and non-formal settings (camps, nature centers and a variety of special events and skills programs).

The importance of such outreach was officially recognized in 1949 when the then Division of Fisheries and Game established an Information and Education program which was charged with generating news releases, radio announcements, exhibits, publications, and accepting "speaking engagements" (these matters had previously been handled by a Supervisor of Claims and Permits.)

Outreach is targeted toward user groups, affected non-user groups, and where possible toward those who may have only a minimal understanding of wildlife and the importance of wildlife management. Today the information and education program is far more complex than it was at its inception. It draws on research from the social sciences, communications, education and journalism, and on technical advances in the fields of video graphics, computer science and the publication industry.

Outreach

Current outreach involves research on public perceptions of the agency and contact with the public in many different venues. Such contacts include participation in public events and issuance of news concerning regulations, events, opportunities and matters of public concern. The I&E Section maintains an interactive and very popular website which offers a wealth of information about wildlife and management issues in the Commonwealth and an electronic mailbox through which it receives, and responds to, a large volume of public inquiry.

A free monthly newsletter, MassWildlife News, is sent out electronically (2500 addresses), by fax (80 copies), and in hard copy (1500) to individuals, organizations and members of the media. Topics include harvest information, regulatory changes, seasonal wildlife topics or phenomena, announcements regarding wildlife recreation opportunities and a calendar of events and meetings.

Education

Much of the broad public education offered by the Massachusetts Division of Fisheries and Wildlife (MDFW) comes through its publications, which include booklets and bulletins designed for specific purposes, and *Massachusetts Wildlife* magazine, a quarterly publication that currently (2005) reaches more than 23,000 paying subscribers. Articles in the magazine, and subjects of bulletins and information sheets, focus public attention on issues of concern to wildlife biologists. These typically include specific species of concern (both game and non-game), threats to species or habitats (e.g. invasive plants and animals), and issues related to the continued conservation of the biodiversity of the Commonwealth (*Massachusetts Wildlife* Vol. LII, # 1 was devoted entirely to this topic 2002).

More specific educational material is offered through bulletins and pamphlets which address such issues as wildlife diseases, managing lands for wildlife, the natural history of common species, a children's book of common animals and more. These are directed to specific sectors of the public and are designed to increase understanding of, and cooperation with, wildlife management and conservation programs.

Ever proactive, the DFW is solidly committed to enhancing connections between youth and wildlife and one portion of this outreach comes through our involvement in the formal educational setting of schools. Programs in this area have, since 1999, been adjusted to coordinate with the Commonwealth's learning standards and with curriculum frameworks for different subject areas. Since 2002 programs have also been shaped by the requirements of the federal No Child Left Behind (NCLB) act. Programs offered in the formal education sector include, but are not limited to:

Project WILD/Aquatic WILD Workshops for Educators
This is an interdisciplinary, conservation education program that emphasizes wildlife, people and the environment. This national program provides supplemental curriculum materials containing over 100 activities for educators of youths in grades K – 12. Because DFW staff is minimal relative to the immensity of the task, the program operates through a cadre of volunteer instructors, trained by a DFW coordinator. The program helps teachers to appreciate the importance of well-integrated and diverse ecosystems and to instill in their students a commitment to making well-informed and responsible decisions.

Other programs offered for use in formal educational settings include:

- **Junior Duck Stamp Program –** A program that celebrates the success of both federal and state waterfowl stamp programs and enlists students to make their own personal contributions to wildlife conservation through art.
- **Massachusetts Envirothon** – A natural resource program and competition for high school students. DFW staff support this multi-partnered program through presentation of teacher and student workshops, service on the education committee, preparation of the examination on wildlife issues and staffing the culminating competition.
- **Vernal Pool Workshops** – These workshops focus learners' attention on vulnerable but important ephemeral wetlands that need public understanding and protection.
- **Biodiversity Days –** The MDFW (in conjunction with EOEA and schools) works with the Massachusetts Association of Conservation Commissions in their program of building public understanding, support, and action to protect biological diversity.
- **Public Education Programs** – Through wildlife education programs, public appearances at conferences, the annual Massachusetts Outdoor Exposition, festivals, workshops and various civic group meetings, staff continue to reach urban youth, scouts, students in grades preK-12, home schooled, pre-service teachers, college students and other adult audiences with materials that enhance appreciation of biodiversity in the Commonwealth.

Outdoor Skills Programs
For the many and diverse non-formal education settings, the DFW offers a variety of skills programs. The success of these programs lies in their ability to connect program participants to outdoor experiences in hope of having them develop a sense of stewardship. As is the case with programs in the formal education process, the agency extends its outreach through programs delivered by well-trained volunteers.

The Angler Education Program
This program aims to enlighten the public, primarily children, about our aquatic systems though the experience of fishing. By introducing, or re-introducing sportfishing to the general public, MDFW promotes stewardship of Massachusetts' abundant waterways, and fishing opportunities, as well as providing a relaxing and healthful way to enjoy the outdoors.

This is a volunteer-based program with approximately 100 active volunteers currently divided among ten workshop groups throughout much of our state. These Volunteer instructors teach people of all ages to fish, as well as environmental issues related to our aquatic resources.

Program components include:

- **Basic Fresh Water Fishing Courses** in each of our workshop groups throughout the year, with the concentration coming in April, May, June, September and October. Approximately 500 participants are taught annually.
- **Family Fishing Festivals** are offered in the spring and summer, providing interested participants with the opportunity to obtain a sound introduction to fishing. We hold approximately 12 to 15 of these events each year.
- Small groups receive instruction through **Fishing Clinics** where the participants are given a basic introduction and overview of fishing, followed by a healthy dose of the real thing. Participation is kept small enough to allow one-on-one instruction. .

Hunter Education Program
It is the mission of the Massachusetts Hunter Education Program to protect the lives and safety of the public, promote the wise management and ethical use of our wildlife resources, and encourage a greater appreciation of the environment through education. The Hunter Education Program is a public education effort providing instruction in the safe handling of firearms and other outdoor activities related to hunting and firearm use. In order to purchase a hunting or sporting license in other states, Canada and Mexico, all first time hunters must have a government issued Hunter Education Certificate such as the one earned through successful completion of a Massachusetts Basic Hunter Education Course. All courses are offered without charge. Courses available include the Basic Hunter Education Course; Bow hunter Education; Muzzleloader Education; Map, Compass and Survival; Trapper Education; and Waterfowl Identification. In keeping with the MDFW commitment to youth, opportunities for effective youth programs are researched and programs are designed to meet the need identified.

Becoming an Outdoors-Woman
Women constitute a largely underserved audience for the DFW. Because the transmission of wildlife-related outdoors skills has traditionally been perceived as a male pursuit, relatively few women are actively involved in wildlife-related activities.

Through this program the DFW offers entry-level workshops in outdoor skills for women. Workshop offerings include basic fishing, shooting sports, kayaking, map and compass, reading the woods, archery, pond and stream adventures, nature photography, martial arts, outdoor and game cooking, edible plants and much more. Designed primarily for women, it provides an

opportunity for adults who may have never tried these activities, but want an opportunity to learn.

Massachusetts Junior Conservation Camp
MDFW provides instructors for a two-week overnight summer camp for girls and boys ages 13 - 17 which is offered by Mass. Junior Conservation Camp, Inc. The camp offers a program of conservation education and instruction in outdoor recreation skills. It introduces youth to the ethical concepts and knowledge essential to a lifetime of properly enjoying our natural resources and the leisure activities that depend on their careful stewardship. Many of the instructional subjects that lend themselves to teaching about biodiversity include: forestry, soil conservation, wildlife management, orienteering, basic camping and more. A state approved Basic Hunter Education Course and Boating Safety Course is always included in the program. Instruction in "subject matter fields" is provided by state biologists and natural resource professionals.